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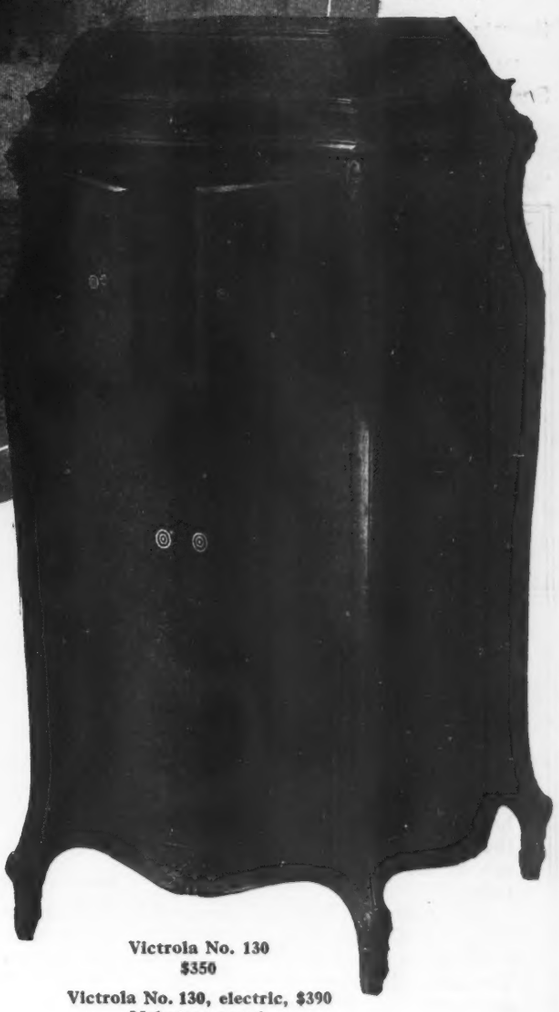

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POPULAR SCIENCE MONTHLY

MARCH, 1923; Vol. 102, No. 3
25 cents a Copy; $2.50 a Year

Published in New York City at
225 West Thirty-ninth Street

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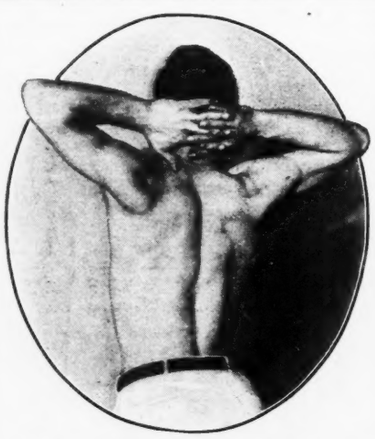
A Foretaste of Features in Our Next Issue

IN THE seclusion of their laboratories a small band of American scientists are laboring desperately to wrest a marvelous natural secret from the green plants around us—a secret that may help us avert a threatening world-wide fuel famine.

These men—among them being distinguished members of the American Association for the Advancement of Science—believe that today we are consuming our oil, coal, and wood at a rate that means early exhaustion of the world's supply. "And then what will happen?" they ask. Civilization would totter, they believe, unless a new source of energy could be found. To find this energy they are turning to the sunlight. For it is really only the stored-up energy of the sun that we use when we burn coal or oil. Therefore, we must find out how coal was made, and to do this we must discover how living plants use sunshine to form the material that was laid down, ages ago, in the form of the coal we mine today.

This secret of trapping the sun's energies is still locked up impenetrably in the green leaves of common plants. The fascinating story of how science is striving to learn this secret will be told in the next issue of POPULAR SCIENCE MONTHLY.



"If you can keep your neck and abdomen strong, you can safely be guaranteed a 50 per cent longer life than the average man." So writes Dr. C. Ward Crampton, noted health expert, who prescribes the above "star gazer" exercise as one of a novel series to promote longer life. See our next issue

DO YOU need exercise? Of course you do; but do you know that there are three distinct classes of exercise and that your particular "exercise diet" should be prescribed by an expert just as carefully as medicine?

Dr. C. Ward Crampton, aide to Secretary of War Weeks, in his nation-wide campaign for better American manhood, will tell in the next issue of POPULAR SCIENCE MONTHLY what your physical shortcomings are and just what kind of exercise you should practise to remedy them. Scholar, machinist, laborer, and bank president—Doctor Crampton holds up the mirror to each and shows just what correcting recreation and exercises he requires.

A DRY cell vacuum tube radio set for $20! Six months ago this sum would have bought you a small crystal receiving set; in the next issue of POPULAR SCIENCE MONTHLY our staff radio expert tells you how to assemble at the same cost a set that will receive from four to five times as far as the average crystal set. You would have to spend $60 or more for an assembled set of equal efficiency.

An accompanying article describes a novel three-stage vacuum tube set, using power tube amplifiers, which was built to obtain maximum loudspeaker results.

HAROLD F. BLANCHARD, staff automobile expert, has prepared a money-saving article for the April POPULAR SCIENCE MONTHLY, telling of the simple tests every motorist can apply to his car to determine what repairs and adjustments are needed in preparation for summer driving.

DOZENS of other feature stories—informative, entertaining, money-saving — will make the next issue of POPULAR SCIENCE MONTHLY the most interesting publication of the month.

On newsstands everywhere March ninth

POPULAR SCIENCE MONTHLY

Issued monthly. *Single copy*, 25 cents. *Yearly subscription to United States, its possessions, and Canada*, $2.50; *foreign countries*, $3.

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H. J. Fisher, *President*; R. C. Wilson, *Vice-President*
O. B. Capen, *Secretary and Treasurer*

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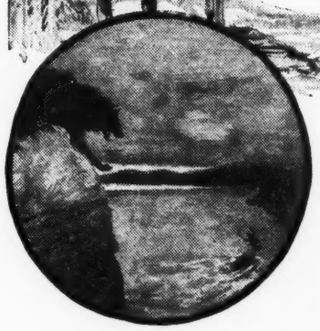
From the Great White Way *to the* Great White Spaces

Get away from the grind of your daily routine. James Oliver Curwood is waiting to take you, while you sit in your easy chair, to the magic outdoors of the great Northwest, where interesting adventures make your blood run fast.



This great author knows the animals of the wilderness more intimately than any other writer. His absorbing tales of their adventurous life are laid in the range of country where no hunters go.

Pack up your troubles *and* follow CURWOOD *into* Adventureland

COME to the great magic land of the Northwest — come where the breath of Romance stirs in the blood of men and women—come to the land of adventure, strange, enchanting, wondrous. Stand under the great open sky —gaze at the wondrous Red Moon and the North Star—hear the cry of the wolf pack—thrill to the magic of the forests—sit by the soft glow of the camp-fire—come to the top of the world and feel the spell of the vast white wilderness! You do not have to stir out of your easy chair to do it.

James Oliver Curwood takes you to the North Country, where splendid adventures are always happening—where romance steadily spins her golden web of enchantment. Here is great drama, played by great and fearless men who quicken your red blood and lift you clear of care and worry, carrying you far and happily into Adventureland!

6 Complete Novels–*James Oliver Curwood, Now at a Special Price*

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There never was a writer with the compelling power of James Oliver Curwood. His books have that gripping, broad interest of big things done in a big way. Whether you read about "Baree, Son of Kazan," the story of the little outcast wolf-dog, or about "The Hunted Woman" the appeal fairly takes you by the heart. You find yourself gripped by this great writer's power. As no man has done before, he brings to you the atmosphere of the North, the appeal and mystery of the wilderness, the scent of crisp air, the overpowering sensation of great, untrammeled spaces.

Here are the humor and tragedy, the grief and gladness of a great and glorious country. More than 2,000,000 copies of these books have been sold. The tales have been eagerly sought by moving picture companies.

And now you have the opportunity of obtaining a beautiful six-volume set of James Oliver Curwood at an unprecedented price! At last this world-famous author is brought within the reach of everybody. By acting quickly—that is the condition, remember—you can obtain a wonderful six-volume set of James Oliver Curwood for practically half price! The set, which is beautifully bound in dark maroon cloth, with the titles lettered in gold, has sold regularly for almost DOUBLE the present price!

James Oliver Curwood used to sleep with a young grizzly bear, and as a result of this close study his novel "The Grizzly King" is one of the most entrancing and realistic animal stories ever written

Send No Money

If you are tired of ordinary novels, if you are "fed up" with the humdrum of your daily routine, if you want to feel the clean white snow of the great Northwest under your feet, if you want to live among real men and real women, follow Curwood into adventureland. Don't bother to send any money. Merely mail the coupon and the six volumes of Curwood will be sent to you at once. When they arrive you have the privilege of examining them for seven days, and then paying for them in small monthly installments. This offer is good only while the present special edition is available. Take advantage of it now—mail the coupon at once and make sure of your set.

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Read the World's Most Amazing Story

From model by Dwight Franklin

THIS slinking, fear-ridden, half-human creature, emerging from the black night of time toward the dawn of civilization, was your first ancestor—the ape-man, whose story you will read in coming issues of POPULAR SCIENCE MONTHLY.

Millions of years ago he skulked through the forests of what we now call Asia. He dwelt always in a black fog of fear. He was in terror of the savage beasts around him, of the hail and lightning and thunder; of the cold and darkness. He was dwarfed by all the menacing powers of nature. He was only a trembling experiment. He might have been utterly stamped out—and with him would have vanished the promise of our human race to come. But two things saved him: He had hands with which to clutch stones as weapons, and within his savage skull there was the glimmer of a mind.

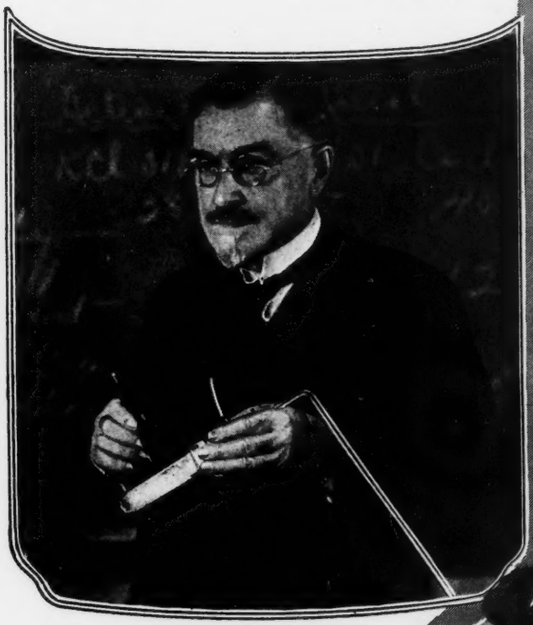
How this creature developed a real brain and a human form; how he learned to invent tools, to hunt in bands, to kindle fires and build a hut, to tame wild animals and plant grain—these great discoveries of science are told in the most fascinating serial ever published.

It is "The Story of Man and His World," by Dr. E. E. Free, beginning in this issue of POPULAR SCIENCE MONTHLY, to run throughout the year. It will show you a breathless panorama of man's conquest of nature, and of the great fundamentals of science that everybody wants to know.

You owe it to yourself not to miss a single instalment

Men of the Hour in Science and Discovery

Close-Ups of Some of the Makers of Tomorrow



Probes Life Secrets

ONE of the world's most famous desert explorers, Dr. D. T. MacDougal, general secretary of the American Association for the Advancement of Science and a tireless worker in the field of botany, has actually succeeded in devising an artificial cell that behaves much like the living cells of plants.

By means of remarkable apparatus shown above he is able to simulate many properties of living protoplasm, such as the process by which living plant cells absorb food materials.

Luther Burbank

THE best loved and most picturesque of America's great scientists this month rounds out his fiftieth year of labor in plant wizardry—an event that is being celebrated by California, his home state.

During half a century of achievement, Luther Burbank has evolved more new species of valuable plants than any other man.

In next month's issue he will tell in his own words the fascinating story of his life work and of his dream, at the age of 74, of applying the laws of plant raising to creating better humans.

Teaching Us to Travel by Air

COMPLETING arrangements for a 5000-mile air trip to the Arctic Circle in a palatial flying boat, Charles F. Redden hopes to confirm further his belief in the practicability of long distance commercial aviation in America—a belief that induced him to organize the Aeromarine Airways, Inc.

Instead of merely talking about a "glorious future for commercial aviation," Redden set out to make a record in aerial transportation. In the second year of operation, his company carried 9107 passengers 739,047 passenger miles without a mishap.

His proposed journey to the Arctic is the first step to establish regular aeromarine service between New York City and the Far North. With him will go half a dozen businessmen-sportsmen bent on an arctic hunting expedition. Plans for the voyage are described on page 59 of this issue.

A Famous Young Explorer

IN LONG and hazardous exploration trips through China, Roy Chapman Andrews (at left) has collected thousands of strange fossils that are giving us amazing new knowledge of life on earth in prehistoric times, making it possible for science to piece together, bit by bit, the world's history.

This young scientist of the American Museum of Natural History (who incidentally is one of the world's leading authorities on whales) has explored Alaska, the Dutch East Indies, Borneo, Asia, and right now is in Peking, preparing for his third expedition through the Gobi Desert of China, where he has discovered the remains of giant reptiles and what scientists believe to be the first mammals.

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Waterfall Plunges from Power Plant "Safety Valve"

IMAGINE a great stream of water flowing through a mountain tunnel nearly two miles long, then rushing with tremendous force through 15-foot penstocks, or power house supply conduits, at the rate of 1800 cubic feet a second.

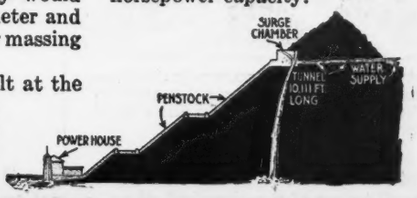
What would happen if valves in the penstocks were suddenly closed, causing this great body of surging water to gather its full force and strike a terrific blow, like some gigantic sledge hammer, against the walls of the conduits?

That is the problem that confronted engineers in constructing the Pitt River power plant, which supplies the San Francisco Bay region in California. By experimenting with miniature models, they learned that to prevent the pipe lines from bursting under hammer blows from sudden changes in pressure within the pipe, they would require a chamber 60 feet in diameter and 55 feet deep to take off the surge, or massing of waters.

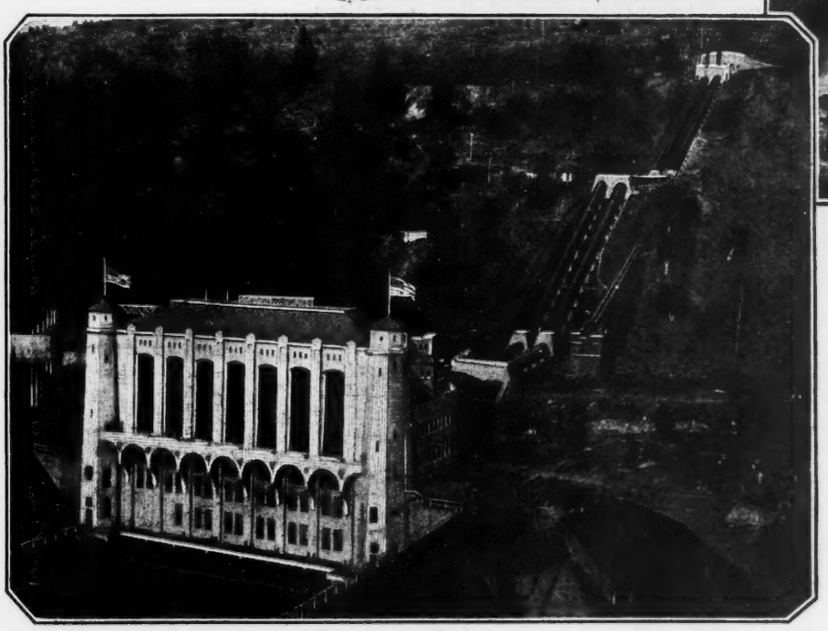
Such a surge chamber they built at the penstock end of the 10,111-foot tunnel. At normal times, water flows from the tunnel through the surge chamber, and from there directly into two penstocks 1370 feet long. The flow is governed by two butterfly valves, 10 feet nine inches in diameter, said to be the largest in the world.

When it is necessary to divert the water from the plant, these valves are closed, the surge chambers overflow, and the water is diverted to one side, plunging over a precipitous cliff to the bed of the river 400 feet below.

This plant is but one unit in a gigantic power development project which, when completed, is expected to have 600,000 horsepower capacity.



PLUNGING over a precipitous cliff to the river 400 feet below, this picturesque waterfall represents a tremendous force of excess waters from the Pitt River power plant, Calif.—a surging mass that, if suddenly arrested in the penstocks by the closing of valves, would act as a gigantic sledge hammer, breaking the pipes



THIS seething water flows from a surge chamber—the safety valve of the power plant—stationed at the head of the penstocks and at the end of a two-mile supply tunnel through a mountain, as shown in central diagram. When penstock valves are closed, the surge chamber overflows, the overflow being diverted over the cliff as shown above

The photograph at the left shows the magnificent Pitt River power house.

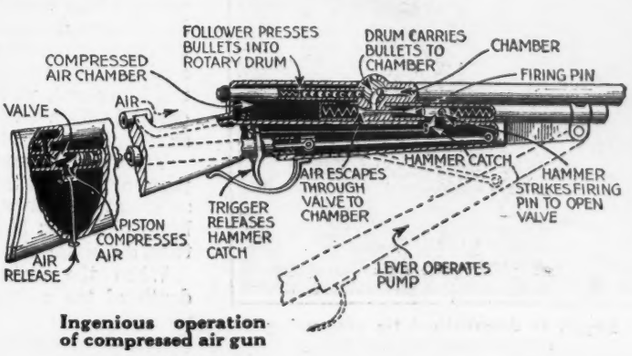
Compressed Air Shoots Round Bullets from High Power Rifle

AMMUNITION costs for hunters may be greatly reduced through the invention of a high power pneumatic rifle by A. V. Dickey, of Seattle, Wash. The gun uses compressed air under 600 pounds pressure and is said to have a muzzle velocity of 200 feet a second greater than that of the ordinary small caliber powder rifle.

A lever attached beneath the rifle is connected with an air pump. This lever is moved back and forth until sufficient pressure has been obtained in the air reservoir in the stock.

Spherical bullets are then inserted in a chamber behind the breach, a cocking slide on the right side is moved forward, carrying one of these bullets into the gun chamber.

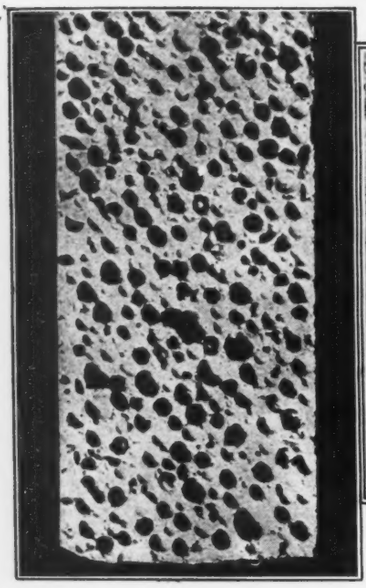
Pulling the trigger releases a hammer that strikes a firing pin attached to the air release valve. The instant the valve remains open is sufficient to allow a quantity of air under a pressure of 600 pounds to escape, forcing out the bullet.

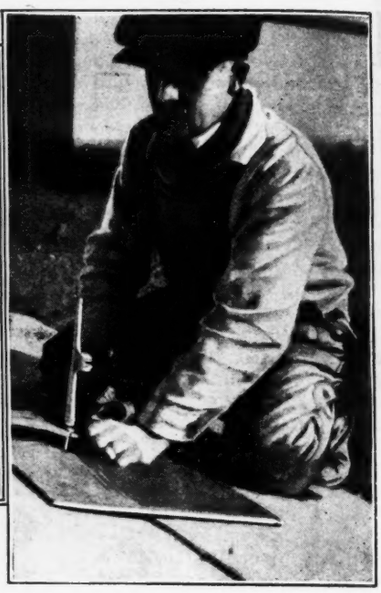


Ingenious operation of compressed air gun

The operator pumps air into a reservoir in the stock of this high powered pneumatic rifle. Spherical bullets are inserted, and the trigger, when pulled, opens a valve, releasing enough compressed air to drive out the bullet at high velocity

Porous Concrete "Boards" Are Fastened by Nails





Nailed to wooden studding, porous concrete slabs an inch thick form the walls of this attractive garage. The structure of the material is shown in the actual size cross section at the left

THIN, porous concrete slabs that are extremely light in weight yet strong enough to withstand a crushing pressure of 600 pounds to the square inch have been developed recently by a New Jersey manufacturer.

Reinforced by wire netting, these concrete boards, only an inch thick, can be nailed to studding much as lumber would be. Because of their peculiar air-cell structure, they are said to be exceptionally effective heat and sound insulators; while their resistance to heat, steam, or water, it is claimed, make them comparatively fireproof.

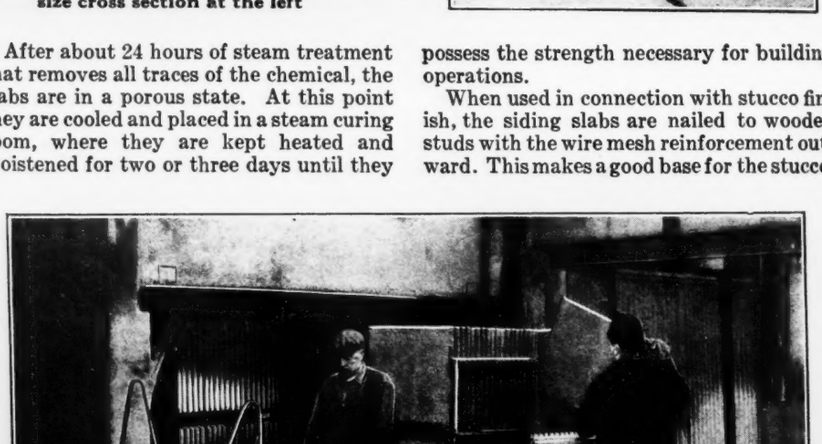
Mixed with Wax-like Pellets

In manufacturing the slabs, cement and sand are mixed with a specified quantity of small pellets of a secret chemical composition resembling paraffin wax. After water is added, the cement, sand, and pellets are mixed thoroughly, then poured into a steel form over wire netting reinforcement.

As soon as the cement has set, the slabs are removed from the forms, placed on steel cars and hauled to a steam tank where, under the action of exhaust steam, they are heated rapidly. This heat melts the waxlike pellets, which drip out of the slabs into receptacles beneath the steam tank.

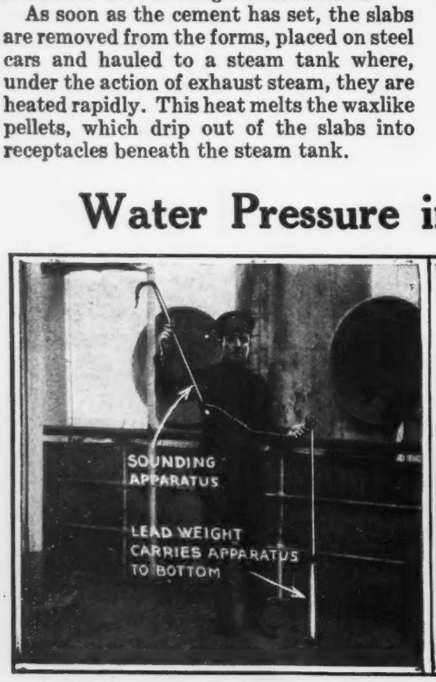
After about 24 hours of steam treatment that removes all traces of the chemical, the slabs are in a porous state. At this point they are cooled and placed in a steam curing room, where they are kept heated and moistened for two or three days until they possess the strength necessary for building operations.

When used in connection with stucco finish, the siding slabs are nailed to wooden studs with the wire mesh reinforcement outward. This makes a good base for the stucco.

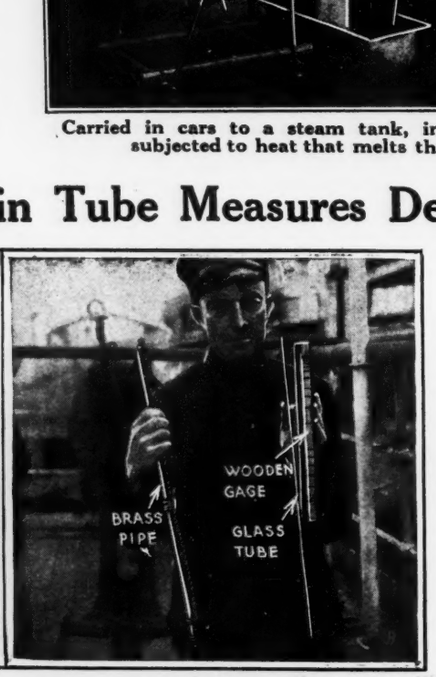


Carried in cars to a steam tank, in background, the unfinished slabs are subjected to heat that melts the waxlike pellets, producing pores

Water Pressure in Tube Measures Depth of Soundings



The brass pipe sounding apparatus, with weight attached to sink it



Depth is determined by measuring rise of water in glass tube

AN INGENIOUS sounding instrument now in general use consists of a brass pipe inclosing an air-filled glass tube and a lead weight that carries the instrument to the bottom of the body of water where soundings are to be made. Depths are determined by noting the extent to which water pressure compresses the air in the glass tube. The tube is open at the lower end, while the inside surface is covered with a water soluble dye. The instrument is suspended from a thin wire.

The water pressure at any depth is proportional to that depth; hence, as the instrument tube sinks, the water entering the brass pipe rises higher and higher in the tube, dissolving the dye as it rises.

When the instrument is raised, the depth of the sounding is determined by measuring, on a scale graduated in fathoms, the extent of the tube that is free from dye.

The Story of Man and His World

Beginning the Most Fascinating Serial of Science Ever Published

E. E. Free, Ph.D., scientist, engineer, traveler and writer of popular science

Especially Written **By Dr. E. E. Free** *for Popular Science Monthly*

Prepared with the co-operation of some of the world's leading scientists

DR. E. E. FREE, America's best writer of popular science, begins herewith a wonderful series of articles on the secrets of life and mysteries of evolution. He tells the story of how the Life Force first took shape in the sea, a billion years ago; of how it grew into countless strange new forms; of how worms, lizards, reptiles, and apelike creatures each in turn inherited the flame of life and passed it on to still higher animals; of how finally Man himself emerged.

And Doctor Free tells not only the *Story of Life*, but the *Story of Science*, by which we have learned Life's secrets. He tells how men have read Nature's picture-writing in the rocks, explored the heavens, probed the secrets of invisible atoms, discovered queer animals in far corners of the globe, and finally pieced all these clues together into one majestic drama of the ages.

Behind this drama some may see moving a Divine Plan of things; others simply the thrilling work of blind chance; but none can fail to be inspired to awe by the natural wonders so vividly presented in Doctor Free's straightforward narrative of fact.

Thanks to the co-operation of many eminent scientists whose help Doctor Free has had in preparing each article, the most amazing recent discoveries of science are now put within reach of the average busy man for the first time.—THE EDITOR.

First Article:

The Dawn of Life

WE KNOW today that the earth is very old, older by millions of years than the scientists of twenty years ago would have believed possible. We now know that the great drama of life on earth, the drama in which you and I are playing our little parts, has been going on for more than a billion years.

Think what this means. A period so incomprehensibly long that a man's whole lifetime is but a few seconds in comparison!

Yet step by step back into this tremendous abyss of time we are now able to trace the evolution of man, the story of how every living thing in the world developed out of tiny life germs first born in the sea some thousand million years ago.

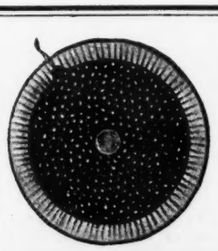
Suppose you could have been present then—what would you have seen? In pools along the margin of the sea you might have discovered a speck or two of transparent jelly; here and there on the surface a little scum of slime. You would not have recognized them for living things alone.

Behind the seashore rose smoke-crowned volcanoes. Against the barren cliffs surged storm waves of the primeval sea. Earthquakes rocked the land. Lightnings flashed; thunders rumbled; down over the rocks there poured the floods of rain.

And in the midst of all these natural wonders the greatest of them all would have gone unnoticed. For the greatest of them, the most significant, the most important in earth history, were undoubtedly just those small slimy specks washing about in the seashore pools.

These slime specks, or something very like them, became the parents of every living thing on earth. They were the first ancestors of man.

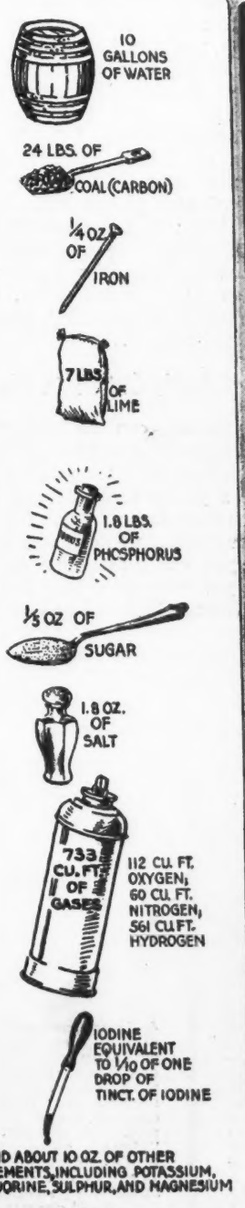
Where these first living particles came



The human body grows from a single egg cell, such as that shown highly magnified at left. Less than a hundredth of an inch in diameter, it can produce an adult man composed of thousands of separate tissues and containing all the chemical elements illustrated at right

What Your Body Is Made Of

The Story Told in Pictures


10 GALLONS OF WATER
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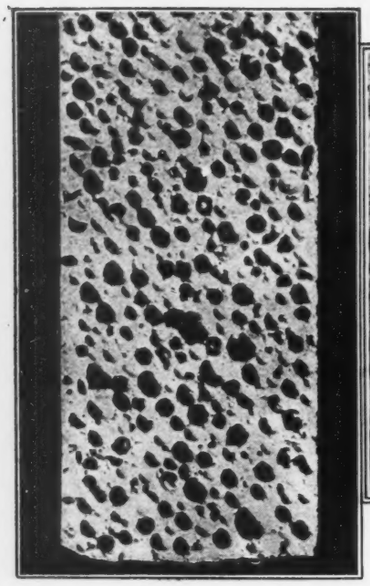
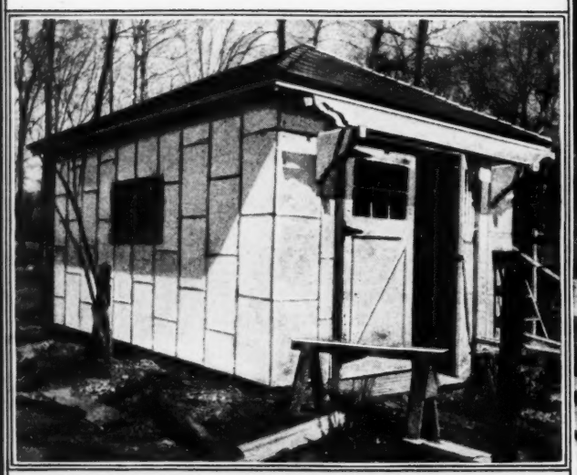
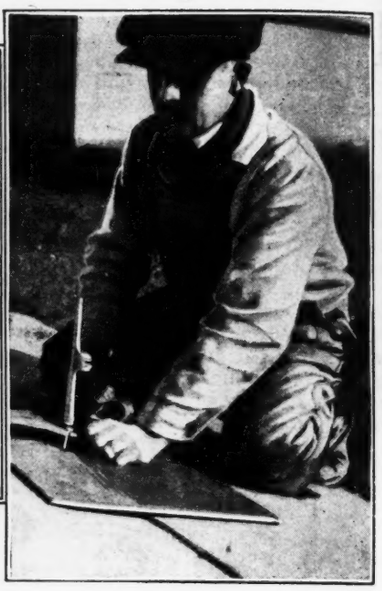
Porous Concrete "Boards" Are Fastened by Nails







Nailed to wooden studding, porous concrete slabs an inch thick form the walls of this attractive garage. The structure of the material is shown in the actual size cross section at the left

THIN, porous concrete slabs that are extremely light in weight yet strong enough to withstand a crushing pressure of 600 pounds to the square inch have been developed recently by a New Jersey manufacturer.

Reinforced by wire netting, these concrete boards, only an inch thick, can be nailed to studding much as lumber would be. Because of their peculiar air-cell structure, they are said to be exceptionally effective heat and sound insulators; while their resistance to heat, steam, or water, it is claimed, make them comparatively fireproof.

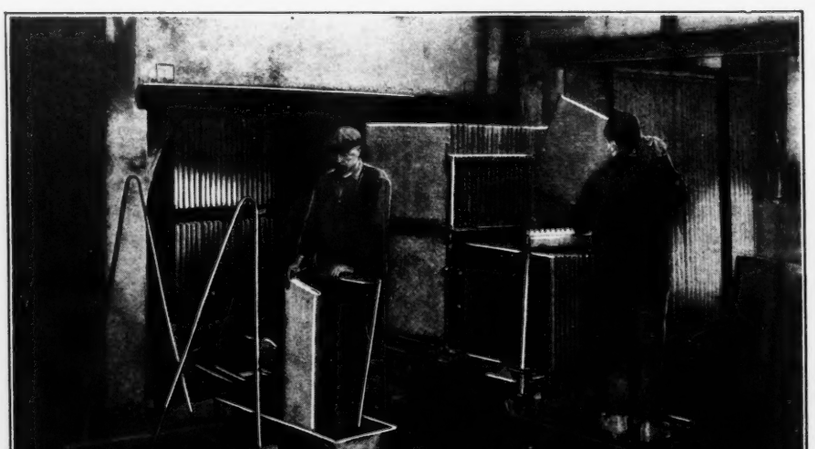
Mixed with Wax-like Pellets

In manufacturing the slabs, cement and sand are mixed with a specified quantity of small pellets of a secret chemical composition resembling paraffin wax. After water is added, the cement, sand, and pellets are mixed thoroughly, then poured into a steel form over wire netting reinforcement.

As soon as the cement has set, the slabs are removed from the forms, placed on steel cars and hauled to a steam tank where, under the action of exhaust steam, they are heated rapidly. This heat melts the waxlike pellets, which drip out of the slabs into receptacles beneath the steam tank.

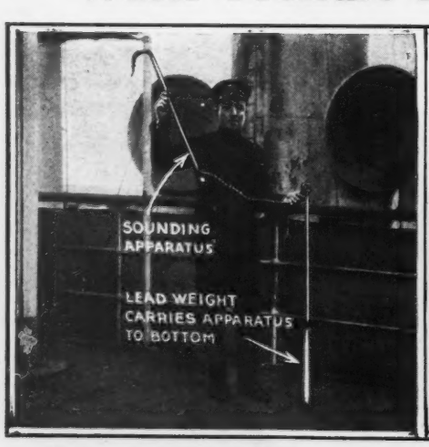
After about 24 hours of steam treatment that removes all traces of the chemical, the slabs are in a porous state. At this point they are cooled and placed in a steam curing room, where they are kept heated and moistened for two or three days until they possess the strength necessary for building operations.

When used in connection with stucco finish, the siding slabs are nailed to wooden studs with the wire mesh reinforcement outward. This makes a good base for the stucco.



Carried in cars to a steam tank, in background, the unfinished slabs are subjected to heat that melts the waxlike pellets, producing pores

Water Pressure in Tube Measures Depth of Soundings



The brass pipe sounding apparatus, with weight attached to sink it

Depth is determined by measuring rise of water in glass tube

AN INGENIOUS sounding instrument now in general use consists of a brass pipe inclosing an air-filled glass tube and a lead weight that carries the instrument to the bottom of the body of water where soundings are to be made. Depths are determined by noting the extent to which water pressure compresses the air in the glass tube. The tube is open at the lower end, while the inside surface is covered with a water soluble dye. The instrument is suspended from a thin wire.

The water pressure at any depth is proportional to that depth; hence, as the instrument tube sinks, the water entering the brass pipe rises higher and higher in the tube, dissolving the dye as it rises.

When the instrument is raised, the depth of the sounding is determined by measuring, on a scale graduated in fathoms, the extent of the tube that is free from dye.

The Story of Man and His World

Beginning the Most Fascinating Serial of Science Ever Published

E. E. Free, Ph.D., scientist, engineer, traveler and writer of popular science

Especially Written **By Dr. E. E. Free** *for Popular Science Monthly*

Prepared with the co-operation of some of the world's leading scientists

DR. E. E. FREE, America's best writer of popular science, begins herewith a wonderful series of articles on the secrets of life and mysteries of evolution. He tells the story of how the Life Force first took shape in the sea, a billion years ago; of how it grew into countless strange new forms; of how worms, lizards, reptiles, and apelike creatures each in turn inherited the flame of life and passed it on to still higher animals; of how finally Man himself emerged.

And Doctor Free tells not only the *Story of Life*, but the *Story of Science*, by which we have learned Life's secrets. He tells how men have read Nature's picture-writing in the rocks, explored the heavens, probed the secrets of invisible atoms, discovered queer animals in far corners of the globe, and finally pieced all these clues together into one majestic drama of the ages.

Behind this drama some may see moving a Divine Plan of things; others simply the thrilling work of blind chance; but none can fail to be inspired to awe by the natural wonders so vividly presented in Doctor Free's straightforward narrative of fact.

Thanks to the co-operation of many eminent scientists whose help Doctor Free has had in preparing each article, the most amazing recent discoveries of science are now put within reach of the average busy man for the first time.—THE EDITOR.

First Article:

The Dawn of Life

WE KNOW today that the earth is very old, older by millions of years than the scientists of twenty years ago would have believed possible. We now know that the great drama of life on earth, the drama in which you and I are playing our little parts, has been going on for more than a billion years.

Think what this means. A period so incomprehensibly long that a man's whole lifetime is but a few seconds in comparison!

Yet step by step back into this tremendous abyss of time we are now able to trace the evolution of man, the story of how every living thing in the world developed out of tiny life germs first born in the sea some thousand million years ago.

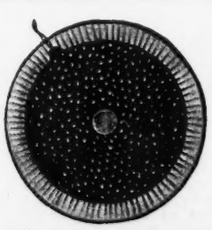
Suppose you could have been present then—what would you have seen? In pools along the margin of the sea you might have discovered a speck or two of transparent jelly; here and there on the surface a little scum of slime. You would not have recognized them for living things alone.

Behind the seashore rose smoke-crowned volcanoes. Against the barren cliffs surged storm waves of the primeval sea. Earthquakes rocked the land. Lightnings flashed; thunders rumbled; down over the rocks there poured the floods of rain.

And in the midst of all these natural wonders the greatest of them all would have gone unnoticed. For the greatest of them, the most significant, the most important in earth history, were undoubtedly just those small slimy specks washing about in the seashore pools.

These slime specks, or something very like them, became the parents of every living thing on earth. They were the first ancestors of man.

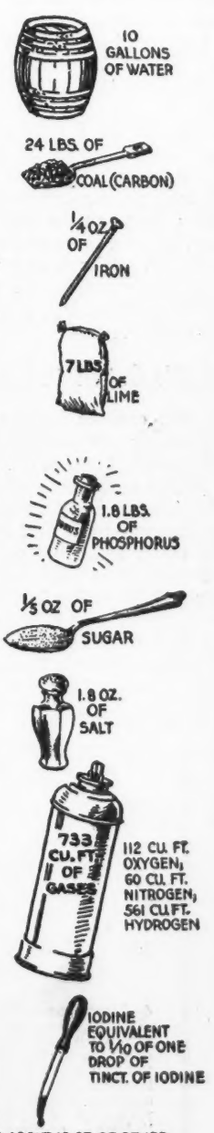
Where these first living particles came



The human body grows from a single egg cell, such as that shown highly magnified at left. Less than a hundredth of an inch in diameter, it can produce an adult man composed of thousands of separate tissues and containing all the chemical elements illustrated at right

What Your Body Is Made Of

The Story Told in Pictures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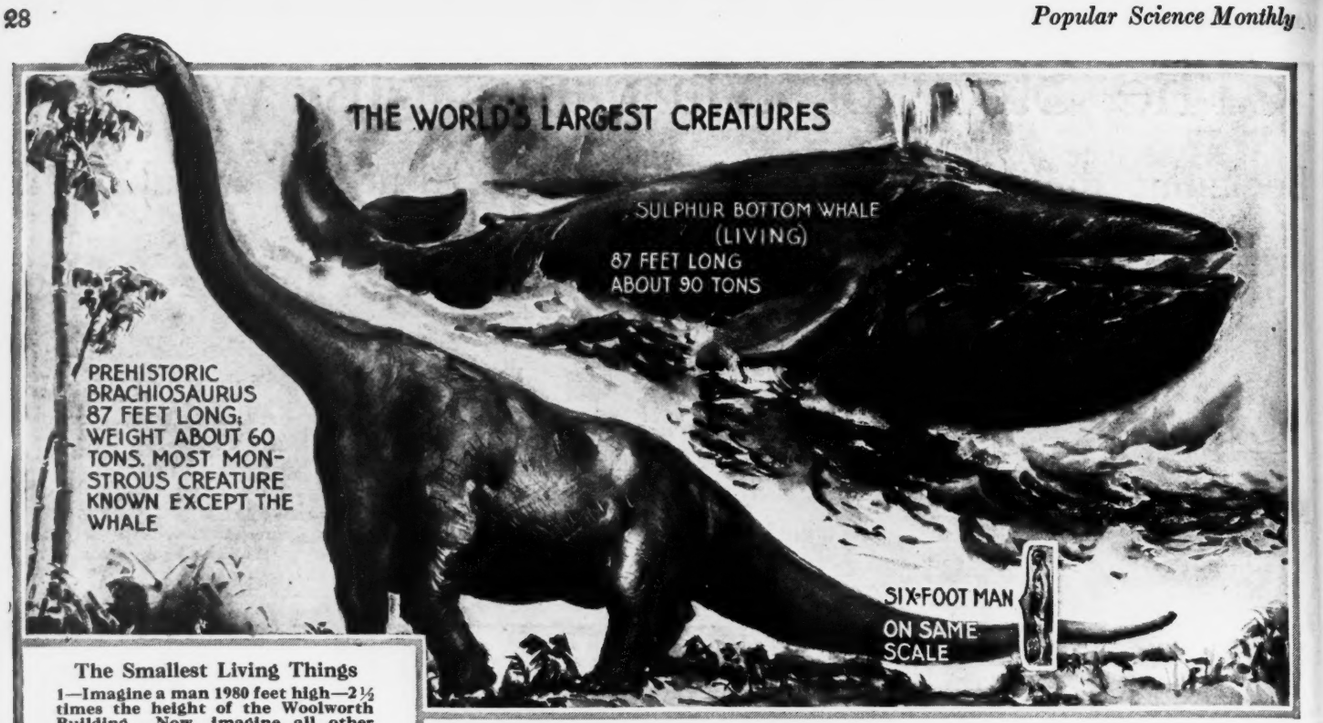

THE WORLD'S LARGEST CREATURES
SULPHUR BOTTOM WHALE (LIVING) 87 FEET LONG ABOUT 90 TONS
PREHISTORIC BRACHIOSAURUS 87 FEET LONG; WEIGHT ABOUT 60 TONS. MOST MONSTROUS CREATURE KNOWN EXCEPT THE WHALE
SIX-FOOT MAN ON SAME SCALE

The Smallest Living Things

1—Imagine a man 1980 feet high—2½ times the height of the Woolworth Building. Now, imagine all other living things enlarged in exactly the same proportion. Then some of the tiny organisms mentioned in this article would be magnified to the actual size shown below. The flagellate is a single-celled water-living creature. The rotifer is a higher form of life consisting of many cells

HUMAN RED BLOOD CORPUSCLE
THE GERM OF TYPHOID FEVER
AT RIGHT, A SMALL ROTIFER, THE SMALLEST MANY-CELLED ANIMAL
ABOVE, A FLAGELLATE PROBABLY RATHER LIKE THE ORIGINAL LIVING ORGANISM

from, we do not know. Distinguished scientists have believed it possible that the germ of life first came to earth from another planet; hidden, perhaps, in the crevices of a meteorite or merely as living dust floating through space. We cannot positively say that this is wrong.

But it is more probable, I think, that living matter originated right here on earth; that in the course of ages, combinations of chemicals took place spontaneously in the primeval sea; that as time went on, these combinations became more and more complex; that finally, without any very sudden change or clear transition, they were alive—they were breathing, growing particles of living matter.

Secrets of Life's Origin in Us

But how, you ask, can we know what the original living matter was like? Strictly speaking, we do not really *know* at all. But we can make a pretty safe guess at it, a guess based on first class scientific reasons.

One of these reasons you can find inside yourself. If you could somehow enlarge yourself until you were some 5000 feet tall —about ten times as high as the Washington Monument—you would be able to see that your bones and muscles and other tissues are not simple materials like glass or wax, but that each one of these tissues consists really of a great assemblage of tiny separate particles which scientists call "cells." There may be as many as a billion of these cells in a cubic inch of flesh. Each human body as a whole contains thousands of billions of them.

Cell Units Perform Varied Duties

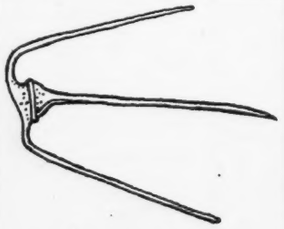
These cells are the units of life. There are many kinds of them in your body, each kind with a different duty. Inside your enlarged self you would see some cells busy making juices to digest food. Others would be lengthening and contracting again as the muscles worked. Still others would be building bone where the skeleton was growing. Most wonderful of all, you would see some cells set apart for nerve duty. Growing out of each one of these, you would notice a long threadlike tail. These tails are gathered into bundles to make up your nerves. Even your highest organ—the brain—is made up of cells, most of them tailed like the nerve cells, their tails connecting with innumerable other cells in the nerves or other parts of the brain and so making up the intricate communication system with which you think and govern your body's actions.

But beside the fact that human beings and all other creatures are composed of cells, we have other reasons for believing

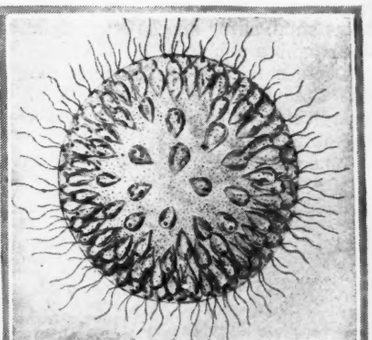
Photo at left by Amer. Mus. of Natural History

2—Scientists read the story of life by studying fossils, which are shapes of ancient animals preserved in the rocks. The photo above shows a fossil "trilobite"—half crab and half insect—just as he was buried in the ocean mud half a billion years ago

3—In the human blood we find tiny cells that live independently. They are the white corpuscles, one of which, enlarged more than 2000 times, is shown above in the act of "eating" a disease germ by flowing around it



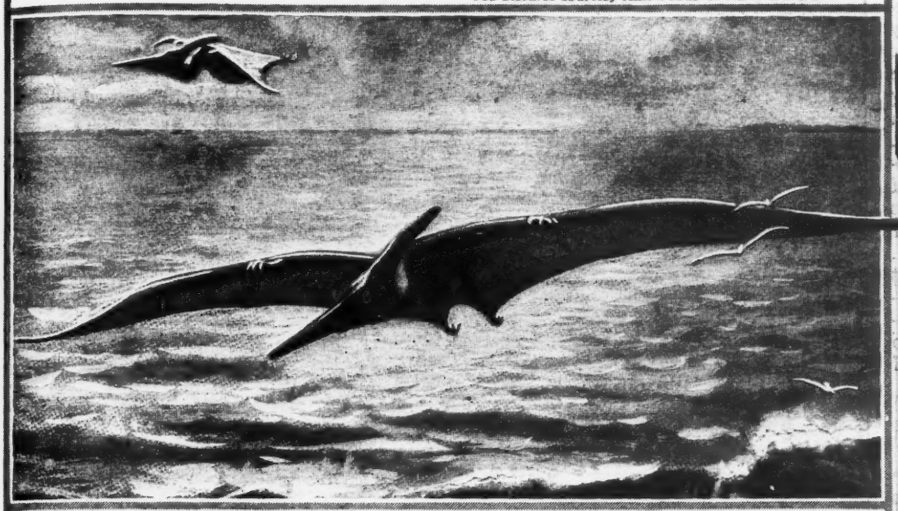
4—Here is one of the "single celled" creatures that make up the "plankton" of the sea. Millions like it float in every cubic inch of surface sea water. The earliest living thing was probably a single celled "plant animal," even much simpler than this. The "plankton" feed by absorbing sunlight and food chemicals



5—Life first took form as a single cell. Later, groups of single cells took to living together. The strange microscopic creature above, called "Volvox," consists of such a colony of cells, most of them alike

The Largest Flying Creature that Ever Lived

Top pictures courtesy Amer. Mus. of Natural History



This huge flying dragon, Pteranodon, measuring more than 26 feet from wing tip to wing tip, once lived where the state of Kansas is now. His wings consisted of membranes between his body and an overgrown little finger, some nine feet long. Note three other fingers like claws on his wings. He was a member of the family called Pterodactyls

11—Still living in East Indian forests, this lemur, the Tarsius, is close to the line of descent of man. Some fifty million years ago, lemurs lived in many parts of the world, including North America. From them developed monkeys, apes, and man

that life itself began as a single cell—a microscopic drop of jelly. One of these reasons is that all living things today grow from such a single cell. And not only does every living thing—plant, fish, insect, man—start from a single fertilized egg cell, but it grows to its final complex structure simply by division and subdivision of this cell into intricate cell colonies.

Independent Cells Can Live Alone

Still another reason is that cells do not always live in such colonies. Certain kinds can live alone, each cell for itself. Examine, some day, under a powerful microscope, a few drops of water from a pond, or from the sea, or from one of the little pools that gather in roadside ditches. You will discover a new world, a world crowded with living creatures. Scattered over the field of view of your microscope are clumps of little greenish globes that really are minute plants; now and then you will catch sight of the darting, wriggly forms of tiny animals. Along the bottom of your water-drop world you may see another animal creeping; a sluggish one, without any visible internal organs, continually changing in shape, looking merely like a speck of slime, yet unquestionably alive. Scientists call this creature the amœba.

All these myriads of creatures that fill the water-drop world are so small that the unaided eye of man would never have suspected their existence. And most of them are single living cells, a good deal like the cells of your body, except that each one of them is independent and lives by itself.

There are even some one-celled creatures like this that live inside your body as necessary parts of it, but without being attached to other cells and, so far as we can determine, independent, just as though they were separate living creatures that merely condescended to make our body their home and do enough work to earn their keep.

These free-living cells inside us are the white corpuscles of the blood. Under the microscope they are merely little specks of translucent grayish jelly. They look for all the world like the creeping jelly-drop amœba that you saw under your microscope in the ditch water. These white corpuscles float around in the blood, visiting all parts of the body together with the ordinary red corpuscles that give the blood its color. So long as we are well, they do not seem to have very much to do.

How White Corpuscles Attack Germs

But suppose disease germs invade the body somewhere. The white corpuscles immediately mobilize like a well-trained army at the point of the germs' attack. Wherever they find one of the invading germs, they dispose of it by the simple ex-

Courtesy Amer. Mus. of Natural History

10—The ancient giant reptiles were among the most spectacular creatures developed in the evolution of life. This curious lizard from New Zealand—the tuatera resembles some of them

6 and 7—Photograph of a fresh-water hydra, taken from the only motion picture ever made of this curious animal. The hydra, found in ponds almost everywhere, is about one sixteenth of an inch long

7—Representing one of the simpler forms of the great group of many-celled microscopic animals that probably developed from cell colonies like Volvox (see opposite page), the hydra has eight waving arms about his head. These arms seize food and cram it into the mouth, at the end of the body between the arms. Thus the cells that were all alike in earlier "cell colonies" have now become specialized, and the creature has a body with various parts carrying on different jobs.

The little bulge on the side of the body is a "bud," the beginning of a new hydra. This bulge will grow longer, develop a set of arms of its own, and will finally drift off by itself, a complete new animal. The hydra also reproduces sexually

Photo courtesy Carpenter-Goldman Laboratories

8—The sea squirt, beginning life as a backboned animal, degenerates to plantlike growth

9—Venus' fly-trap—one of the strangest of plants—has on each leaf three little hairs. When an insect touches one of them, the halves of the leaf close, trapping the luckless insect, which the leaf then digests

pedient of eating it up. The way in which they eat it is very interesting. Having encountered a germ, the corpusele proceeds to flow around it. Little knoblike projections are pushed out of the corpuscle's body on each side of the germ; these meet on the farther side and join, so that the luckless germ is actually engulfed inside the body of the corpuscle. Once in there, it is soon digested and troubles our body no more.

Now one of the most curious and interesting facts in all biology is that this way of taking up food by flowing around it is exactly the way in which the ditch-water jelly-drop—the amœba—takes up its food. This tiny free-living creature not only looks just like our body guest, the white corpuscle, but also eats like it. And both illustrate the fact that living matter is made up of individual cells and that some kinds of these cells can live alone.

All Cells Made of Same Material

And not only are all living creatures alike in being composed of cells, but all these cells have inside them very much the same kind of material, a jelly-like substance that scientists call protoplasm. It has much the appearance of uncooked white of egg, though usually a little stiffer.

Living creatures are of the most diverse forms—a starfish, a snake, a man, a tree. One would not expect them to be composed of the same material. Yet they are. They are all made up of cells and all the cells contain protoplasm. So far as we can determine, it is very much the same kind of protoplasm.

How is this to be explained? Quite simply, if we accept, as most scientists do, the idea that all these diverse creatures are descended from a single ancestor, an ancestor who consisted of a drop of protoplasm living as a single independent cell in the primeval sea.

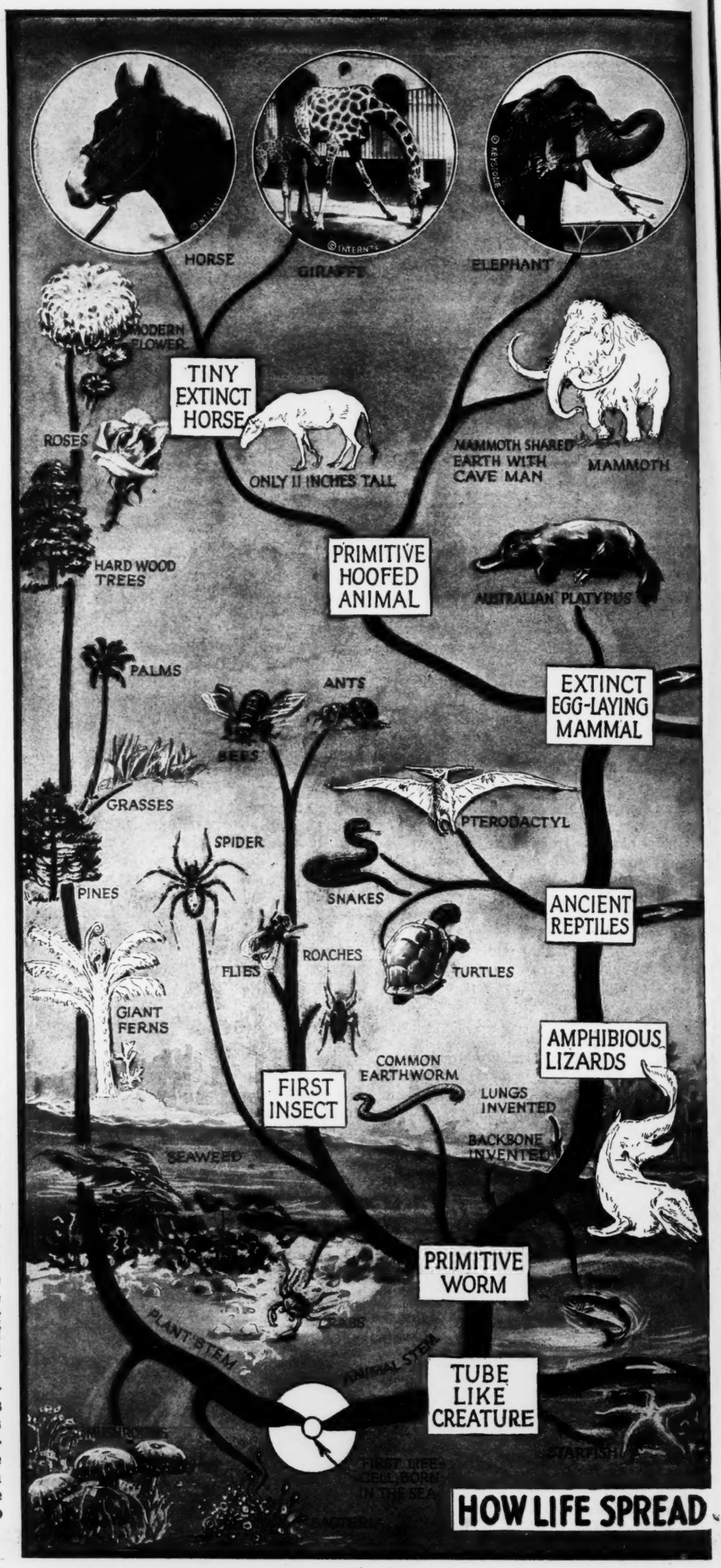
But, although the protoplasm of all cells appears to be much alike, you must not believe that it is *exactly* alike or that modern protoplasm is exactly the same thing as the original living matter. In the millions of years since life began on earth, protoplasm has changed just as everything else has. It has become more complicated. Different varieties of it have been developed to suit the kinds of work carried out by different kinds of cells.

Protoplasm Eats, Breathes, and Moves

The things that protoplasm does are enough to prove that it is complicated. The living cells composed of it are able to eat, to reproduce their kind, often to move about. All of them that have been investigated have another characteristic: They breathe. Human breathing is typical. You take air into your lungs. Oxygen from the air combines chemically with a certain substance in the red corpuscles of the blood. These corpuscles laden with oxygen are then carried to all parts of the body. They give up their oxygen to the body cells. These cells take up the oxygen and use it, giving back to the blood a chemical compound of oxygen with carbon, the compound called carbon dioxide.

This is what breathing always is: Protoplasm takes up and uses oxygen. It gives off carbon dioxide. Every animal breathes in this same way. Every plant does likewise. The one-celled animals, which have no lungs, breathe by taking up oxygen directly through their surface, just as the individual cells inside our body take it up from the blood.

(*Continued on page 118*)



A Picture Story of Evolution

THIS remarkable chart of the family tree of man gives you quickly a vivid idea of how life, originating as a single cell in the sea, spread over the earth, developing into the myriads of queer forms of plants and animals and ending in man.

Start with the white circle at the bottom of the opposite page and follow upward from the primitive cell the four great branches into which this tree of life is divided.

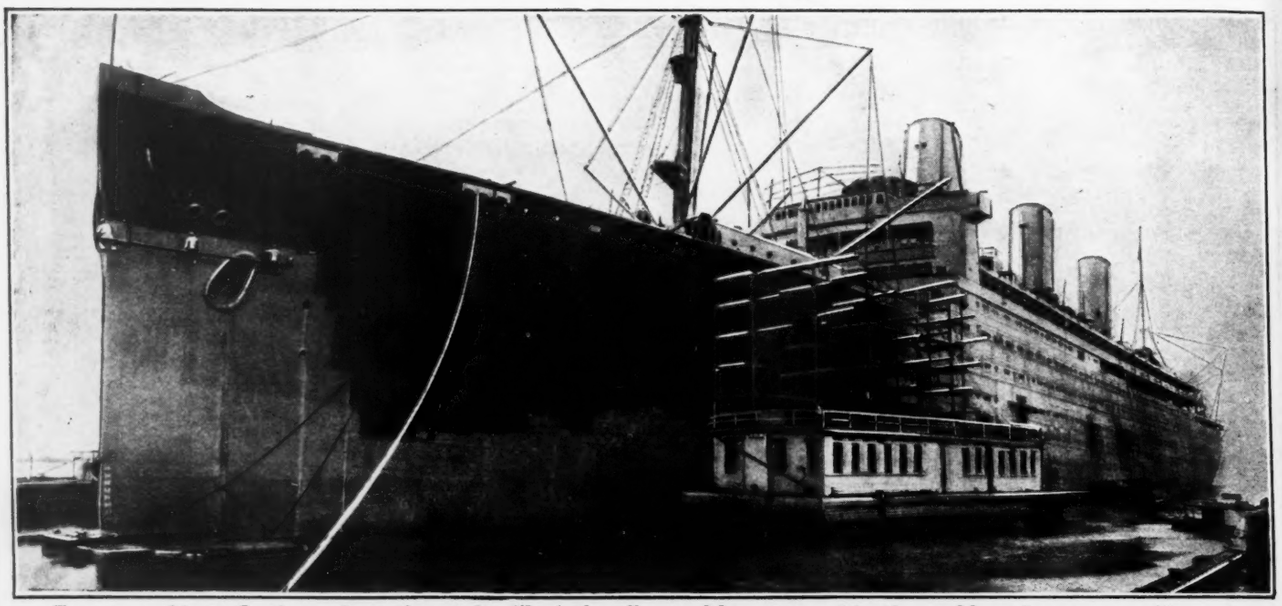
FIRST is the branch of plants. Second is that of the molluscs, culminating in the octopus and giant squid, the most intelligent creatures living in the seas. Third is the great branch of the insects whose highest creatures, the ants and bees, represent the perfection of those social instincts that make each individual a slave to the rules of the hive.

FINALLY there is the great branch of the vertebrates or backboned animals. At their highest point we have MAN. This is the branch of individual intelligence, of creatures who think for themselves instead of obeying blind instincts, as do the ants and the bees. An early human type—the cave man—is shown.

You will find innumerable fascinating points in the chart; note, for instance, the close relationship of bear and dog; the tiny ancestor of the modern horse; how the seal is related to catlike animals, etc.

FROM A SINGLE CELL INTO PLANTS, ANIMALS, AND MAN

Historic "Leviathan" Becomes Queen of the Seas



From troopship to floating palace—the mighty "Leviathan," second largest vessel in the world, as she appears at Newport News, Va., in the process of transformation, at a cost of $8,000,000, into the most magnificent of all passenger liners

THE most stupendous task of its sort ever attempted in the history of shipbuilding is now under way at Newport News, Va., where the historic "Leviathan," next to the largest vessel in the world, is being converted from a battered troopship into the finest passenger liner afloat.

When the monster ship that carried 104,500 United States officers and men in 10 trips to France during the war, sets out on her maiden voyage as a passenger carrier under the American flag early in the present year, she will represent the last word in seagoing luxury.

Five years ago the "Leviathan," formerly the German "Vaterland," was carrying more than 10,000 American soldiers on each trip to France (in one trip she carried 12,000). Two years ago she lay rotting at her pier at Hoboken, N. J., while shipping men called her a "white elephant" on Uncle Sam's hands. They said the day of monster liners had passed, and that the "Leviathan" might as well be towed into the Atlantic and sunk.

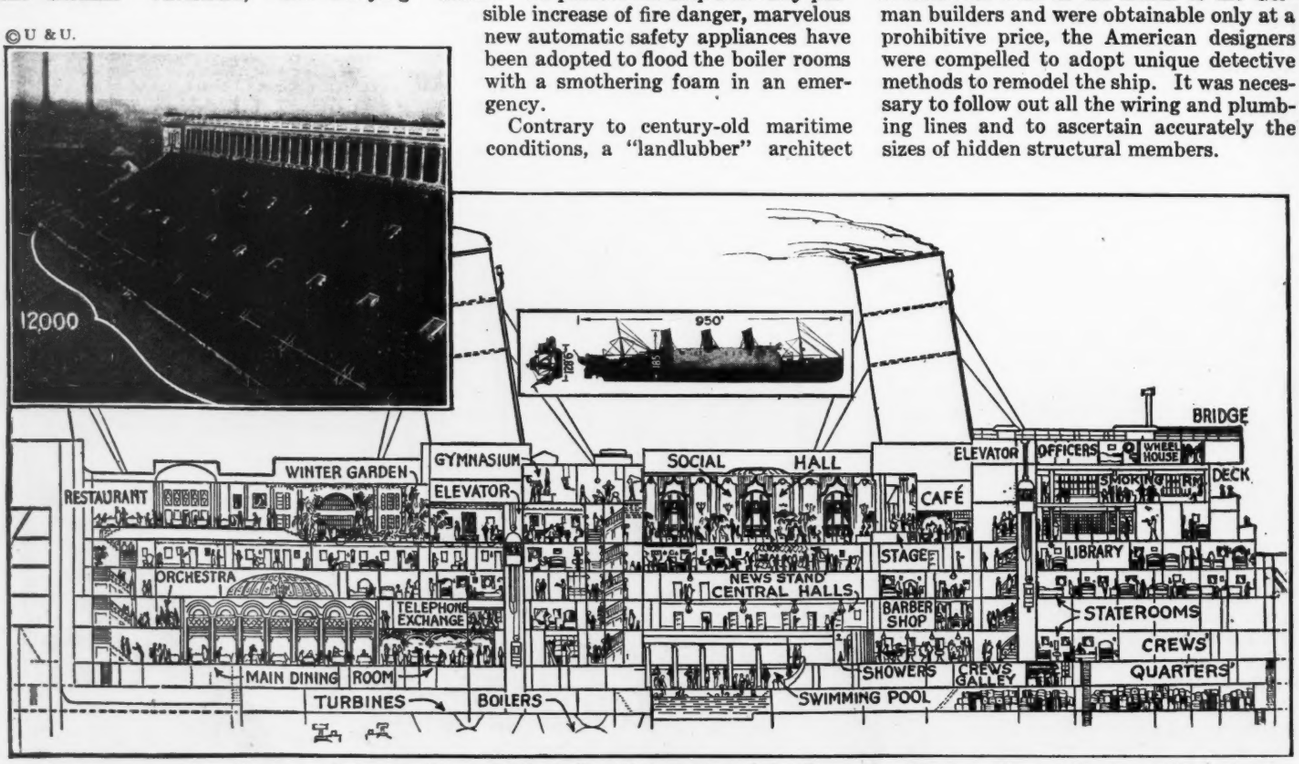
Now more than $8,000,000 and the daily labor of 2500 men are being spent on her to prove that America's merchant marine, after all, can support a liner outclassing the world's finest.

Eleven electric elevators are being installed. Oil will replace coal under her boilers. To protect the ship from any possible increase of fire danger, marvelous new automatic safety appliances have been adopted to flood the boiler rooms with a smothering foam in an emergency.

Contrary to century-old maritime conditions, a "landlubber" architect has been employed to re-design the interior. Her elaborate lighting fixtures will glow with 15,000 electric lamps. The entire ship is equipped with an intricate system of telephone communication, 600 instruments being connected on a central board.

To prepare food for the 5000 passengers and crew, seven complete galleys and four bakeries are being equipped. More than half a million dollars is being spent on the steward's department alone. For the dining rooms there will be 150,000 pieces of china and glassware. On every round trip the vessel will need three tons of tea and coffee, and 186,000 pounds of meat.

Since the only plans of the "Leviathan" in existence were in the hands of the German builders and were obtainable only at a prohibitive price, the American designers were compelled to adopt unique detective methods to remodel the ship. It was necessary to follow out all the wiring and plumbing lines and to ascertain accurately the sizes of hidden structural members.



This cross section diagram of the re-designed "Leviathan," shows arrangement of luxurious passenger accommodations. On one trip during the war, this mammoth vessel carried 12,000 troops—a throng visualized in the larger inset, showing a section of the Harvard stadium. The smaller inset illustrates her tremendous proportions—Columbus' flagship, the "Santa Maria," placed on end, would not reach top of "Leviathan's" funnels. White portion represents section shown below

Record Glider Revives Langley's Tandem Wings

© Flight

The world's record flight of M. Maneyrol's tandem monoplane glider on the Sussex downs, England. Note the amazing altitude gained by Maneyrol by taking advantage of air currents (at right). Inset shows the glider nosing into the wind

By Lorry Jacobs

PREDICTIONS of two far-seeing American aeronauts have been remarkably borne out by the recent record-breaking motorless flight of M. Maneyrol, French airman, in a Peyret tandem monoplane glider in which he stayed in the air for three hours, 21 minutes, and seven seconds, winning the London *Daily Mail's* prize contest on the Sussex downs, England.

In the first place, the design of the machine that made this record follows the essential tandem lines of the famous steam driven "aerodrome" used by Prof. Samuel Pierpont Langley for the second successful flight in history, 26 years ago.

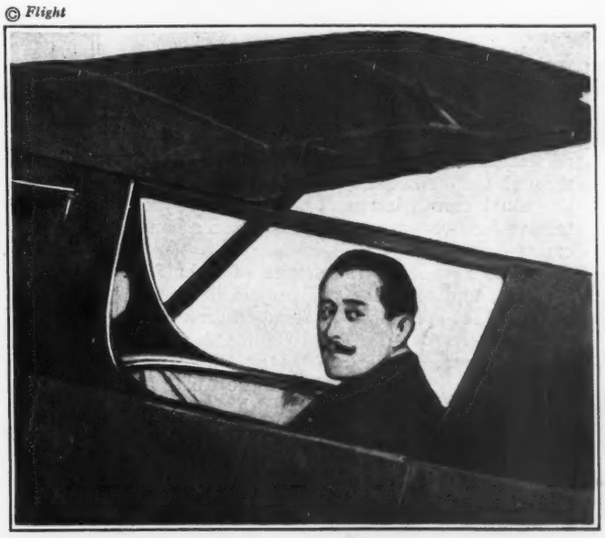
Secondly, the successful methods used by Maneyrol in piloting his glider fulfilled the promise made in the November POPULAR SCIENCE MONTHLY by Augustus Post, secretary of the Aero Club of America, when he said:

"During the period of increasing wind velocity, a pilot of the future will turn his plane head on to the wind and steadily gain height. As the wind decreases in velocity, he will turn at right angles. And at the beginning of a period of minimum wind speed, he will turn tail to the wind." *It was this scheme of flying,* combined with an advantageous and continuous updraft along the take-off hill, that won for Maneyrol.

"The flight resembled that of a bird," says an authoritative report, describing Maneyrol's performance. "Every now and then the glider hovered with its nose to the wind. Sometimes the wind's velocity dropped and the machine began to glide downward and forward. The pilot then resumed his tacking. At other times the wind blew the glider backward slightly, but by 'diving,' Maneyrol got away from the hill 'where he took off.'"

While the tandem monoplane design of Langley has been little used in powered flight because the rear plane is far less efficient than the front one, Peyret realized that the tandem arrangement, when applied to a glider, facilitates control.

© Flight



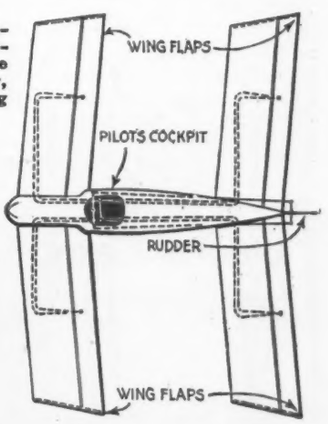
M. Maneyrol, in the cockpit of his Langley-type glider that recently remained in the air three hours, 27 minutes, seven seconds, establishing a new world's record

The wings, characterized by a pronounced backsweep—the front wing being placed at a larger angle of incidence than the rear—consists of light ribs, placed somewhat far apart, carried on tubular spars of duralumin braced by duralumin N struts.

The controls are constructed with a differential formed by three bevel gears so that when the "stick," or control column, is pushed forward, the flaps of the front wings are raised and those of the rear wings lowered. When the stick is pushed to the left, the starboard flaps of both rear and front wings are depressed, those on the port side being elevated. Any combination of forward and sidewise movement of the control stick is possible.

Directional control is obtained by means of a rudder manipulated from a footboard.

Structural details of the Peyret monoplane tandem glider, showing wing control



Compact Oxygen Apparatus for Mountain Climbers

ADVENTUROUS scientists who recently attempted to scale Mount Everest in the Himalayas might have been successful if they had been equipped with a newly invented portable oxygen apparatus, designed especially for mountain climbers and aviators, which supplies just the right amount of oxygen at any elevation.

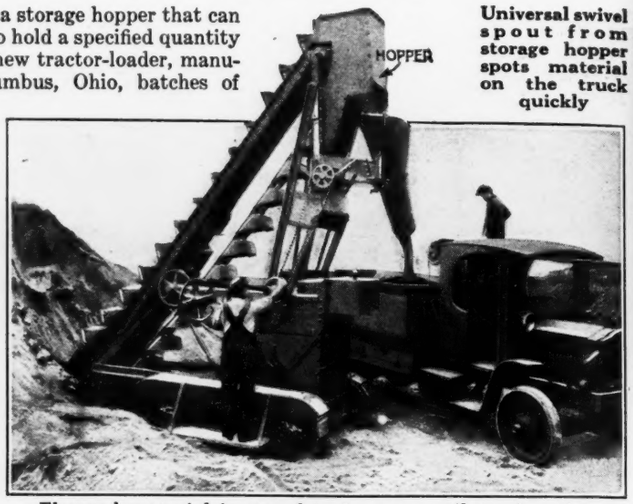
The amount of oxygen required by a mountain climber varies from 61 cubic inches a minute at 13,000 feet to 183 cubic inches a minute at 26,000 feet. Thus at any given elevation, as indicated by a barometer, the valve is set at a corresponding figure, allowing the correct amount of oxygen to enter the breathing bag. A small flap valve prevents exhaled air from entering the bag.

Inability to obtain sufficient oxygen resulted in the failure of the Mount Everest expedition to climb beyond the altitude of 27,364 feet. At the 23,000-foot level, one of the climbers became ill and oxygen was used more extensively; but because of the weight of the apparatus, progress was slow.

Storage Hopper Speeds Up Loader

BY MEANS of a storage hopper that can be adjusted to hold a specified quantity of material on a new tractor-loader, manufactured at Columbus, Ohio, batches of material in desired amounts are elevated to the hopper and held in readiness for the next receiving truck. The fact that the elevator is kept at work continuously greatly increases the capacity of the loader.

A universal swivel spout adds to hopper's efficiency.



Universal swivel spout from storage hopper spots material on the truck quickly

Elevated material is stored in hopper until truck arrives

Calendar-Desk Pad Fed from Paper Roll

EQUIPPED with a roll of paper such as that used with an adding or calculating machine, a handy desk pad recently placed on the market enables the user to record data, from day to day, on a continuous sheet of paper, much as stock quotations are recorded on ticker tapes.

The base of the calendar has a bronze finish.

When the exposed surface of the paper has been used up, the new surface is advanced by pulling on the end of the roll. The paper can then be torn off or left as a continuous record.

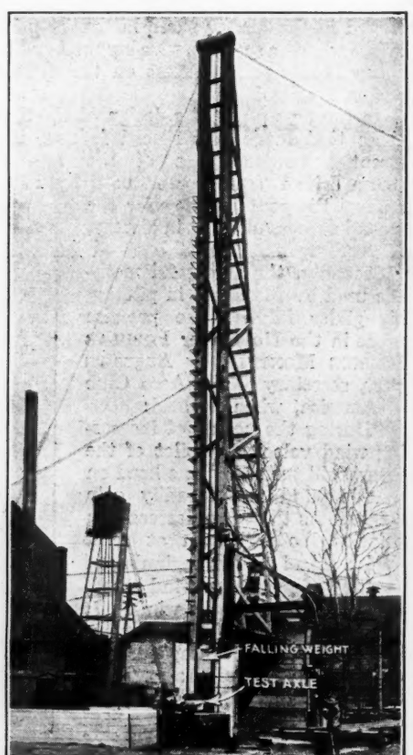
A permanent calendar attached in front of the roll can be used indefinitely.

Falling Ton Weight Tests Strength of Axles

SINCE a single defective locomotive axle may cause a disastrous train wreck, manufacturers submit a certain percentage of each batch of axles turned out to tremendous shock tests.

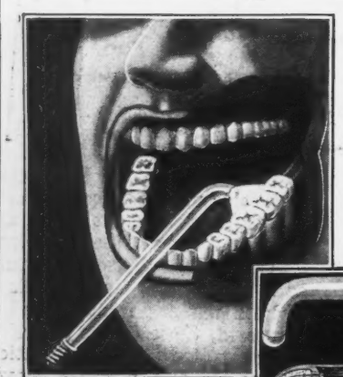
In the final test each axle is supported near the ends while a weight of 2240 pounds is dropped on it twice, the axle being turned through an angle of 90 degrees between the two shocks. These two blows are considered sufficient to reveal any flaws in the material that may have escaped notice in previous examinations.

The height from which the weight is dropped varies with the diameter of the axle. Thus, for a 6 7/16-inch axle, the weight would be lifted to a height of 41½ feet and then dropped.

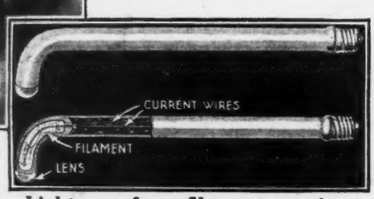


Locomotive axles are tested by a weight dropping on them

Dental Lamp Casts Light through Teeth



How light from the curved lamp passes through teeth under examination

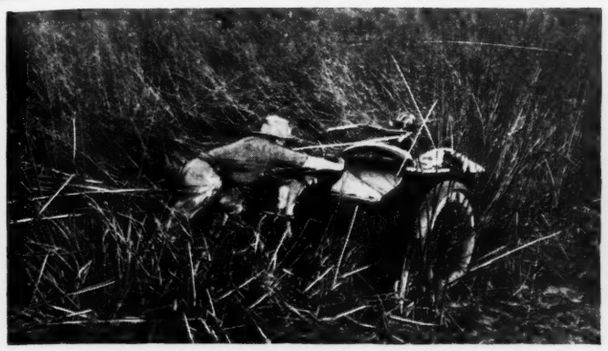


Light rays from filament, passing through a lens, are intensified

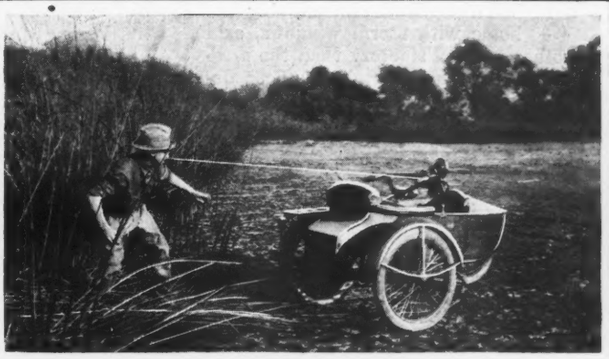
DIFFICULTIES of dental diagnosis have been in part overcome by the recent perfection of a mouth lamp that passes light through the teeth. The fact that the light from the usual mouth lamps is not sufficiently intensive for this purpose has long been a handicap to dentists.

In the new lamp the source of light is a filament, and the rays are projected through a lens that produces intense illumination. The lamp is curved, so that when placed in the patient's mouth, it projects the light at right angles directly through the teeth. Since the lamp tube contains a vacuum, the outside remains cool.

Drives Motorcycle out of Mud and Stops It with His Teeth



Holding in his teeth a cord that controls the motor through an ingenious cut-out switch, the cyclist starts the motor, then boosts the machine out of the mire



With handlebars tied, the machine goes straight ahead. To stop it, the cyclist need only stand still, for the pull on the cord in his teeth shuts off the ignition

BY THE clever use of stout twine and a cut-out switch, a Western motorcyclist has devised an ingenious method of extricating a stalled sidecar motorcycle outfit from heavy mud or sand.

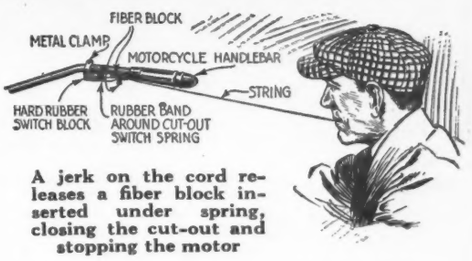
The problem, as analyzed by this cyclist, whose work takes him into almost inaccessible mountain and desert country, consisted of finding a way to give the machine a "boost" while working single handed—operating the motor while pushing and lifting the machine—and also a means of stopping the motor once the machine was out of the hole. Here's the way he solved it:

To keep the stalled machine straight on its course, the motorcyclist simply tied the handlebars. Then, to prevent the machine's running away and being damaged, he fitted an ingenious motor cut-out switch to the right handlebar. This device, a modification of the usual cut-out switch used by motorcyclists for making quick stops, is in the form of a leaf spring, which holds the cut-out switch in circuit, making it necessary to break the circuit to operate the motor.

In order to keep the cut-out switch circuit broken wh le the cyclist works behind the machine, a small block of fiber was inserted under the spring. To this a length of stout cord was attached.

Now, when his sidecar is stalled, the motorcyclist simply ties the handlebars. He then starts the motor, puts the machine in low gear, and engages the clutch, then jumps behind the machine to lift and push it out of the mire. In his teeth he holds the cord attached to the cut-out switch, and the machine goes ahead as long as he follows it. To stop it, he just stands still; for the cord held in his teeth will instantly pull out the fiber block and close the short circuit of the ignition system.

The plan might be applied to an automobile in a similar way

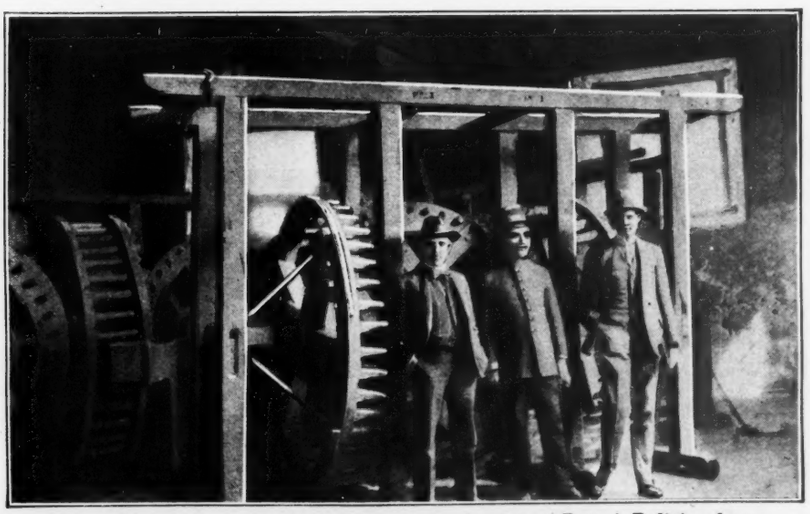


A jerk on the cord releases a fiber block inserted under spring, closing the cut-out and stopping the motor

Mules Drive Wooden Geared Money Presses

WOODEN minting machinery more than 300 years old is still in use for coining medals in the government mint at Potosi, Bolivia. Although the wooden gear wheels resemble those in an old fashioned clock, and it might be expected that either the short wooden pegs or the ladder-like pins would be broken if the gear were called upon to transmit any large amount of power, excellent coins are struck with the machinery. Eight mules provide the power and it is estimated 100 tons pressure can be applied to the dies.

This pin gear, as it is called, has become almost obsolete. It is still seen occasionally in clocks and in feeding devices on milling machines. Wherever wood must be used, however, the pin gear is the perfect design, since the strain is always applied at right angles to the grain of the wood.



The ancient money press in the government mint at Potosi, Bolivia, showing pin gears resembling works in an old clock. This press is 300 years old

Snow Skating Latest Sport

A NEW winter sport has come to us in the form of snow skates, invented by Peter Barlow, of Minnesota, which can be used in gliding over snow only half an inch deep.

The wooden runner has a broad steel shoe and is fastened to the skater's shoe in the same way that ice skates are clamped. The turned up toe serves to pack down the loose snow and to prevent the skater from tripping as the skates sink in.

Double Glass for Storm Windows

A NEW method of equipping the home with storm windows, said to be more satisfactory than the present clumsy outside sash, has been devised by a concern in St. Paul, Minn., which utilizes the regular sash as a base for a second pane of glass.

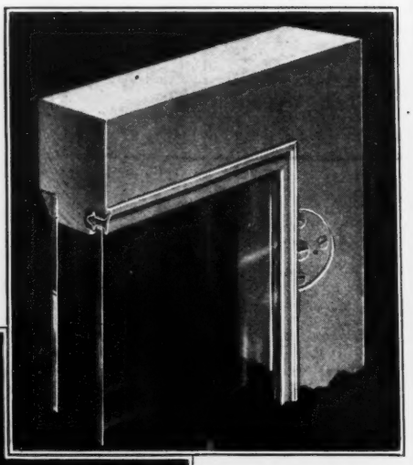
The inside edge of the window sash is cut to receive a metal strip, the side of which is pressed into a groove to receive the pane. This strip is made up into a frame that just fits the window and is held in position by keys provided at several points along the edges.

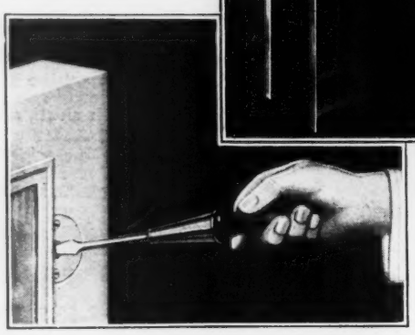
The purpose of all storm windows is to provide a dead air space between two sheets of glass so that the amount of heat lost will be reduced to a minimum. While the old method of attaching additional windows during the inclement weather of the winter months has done this, yet there have been many opportunities for improvements from points of view of economy and beauty.

The new sash does not mar the beauty of a building and, because of this, it can be left in position at all times. The joints are so tight that no dust can penetrate to necessitate cleaning the windows between the panes.

To remove the sash, it is necessary only to turn a screw in the key seat with a screwdriver. This releases the frame and the sash can be withdrawn.

While the sash is made in standard sizes and can be substituted for the ordinary sash in a standard window frame, the molding is especially designed for the storm glass frame.





Above: Second pane of glass fitted into metal strip inserted in inside edge of the sash

At left: Releasing storm window with screwdriver

Portable Stackless Stove Keeps Workmen Warm

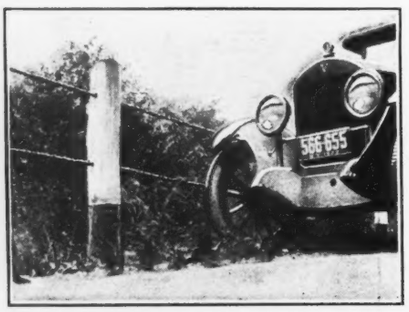
FOR the use of workmen in small shops where there are no heating facilities, and in buildings under construction during the cold weather, a portable coke stove has recently been placed on the market by a manufacturer in Trenton, N. J.

The stove is made of cast iron and has a single opening at the side through which the coke is fed. An opening at the bottom provides the draft necessary for combustion. No stack is provided, since the stove is used in places where it is usually possible to discharge the flue gases into the atmosphere.

Coke is fed through square opening

Sixteen Million Books

FROM 10 to 20 million books have been published since the invention of movable type in 1454, some authorities placing the number more accurately at about sixteen and one half millions. These have been issued in the following order: fifteenth century, 40,000 volumes; sixteenth century, 570,000 volumes; seventeenth century, 1¼ million volumes; eighteenth century, two million volumes; nineteenth century, 8¼ million volumes, and 4 million since the beginning of the present century.



Cable Fence along Highway Protects Motorists

IF ALL highways were lined with a cable fence such as is used on the Lackawanna Trail in Pennsylvania, motor accidents caused by swerving off the road might be minimized and the number of deaths correspondingly decreased.

Two three-quarter-inch cables are stretched between posts on those sections of the highway that run along the side of hills or embankments. Thus, should a car strike the fence with sufficient force to uproot two or three of the posts, the cable, which is continuous, would still hold and would prevent the car from crashing down the declivity.

AS A special service to readers, the Editor will be glad to supply, wherever possible, the names and addresses of manufacturers of devices mentioned in this issue.

Two-Deck Bus Built Close to Ground

DESIGNED to increase safety and comfort for passengers, a double-decked city type motor bus of unusual strength and stability is being built by California manufacturers for interurban transportation.

To insure stability, the frame of the bus is set only 14 inches above the ground, while the gage of the car—the distance between wheel treads—is 70 inches. The frame of the chassis is of six-inch rolled structural steel channel, riveted at all joints.

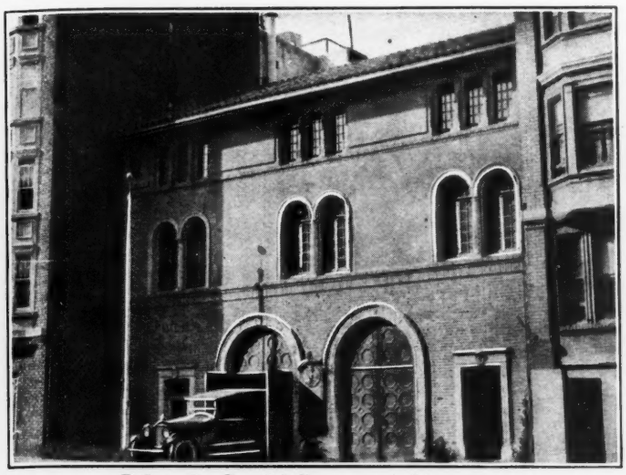
The two decks provide seats for 46 persons—24 in the interior and 22 on the upper deck. Cross seats in the interior are reached through side doors equipped with drop windows, while seats on the upper deck are reached by a flight of steps leading from the front end of the bus.

Drop windows of plate glass running in felt grooves disappear into the doors, which extend to the runningboard.

Driven by a four-cylinder gasoline engine of 62 horsepower, the car will develop a maximum speed of 49 miles an hour. Because of the exceptionally low center of gravity, the bus holds the road well at curves and is practically free from danger of overturning.

The double-decked safety passenger bus, showing low-hung body, stairway entrance to upper deck, and side-door entrances to interior

Special Home Saves Time for Fire Chief



Below the fire chief's rooms is his garage

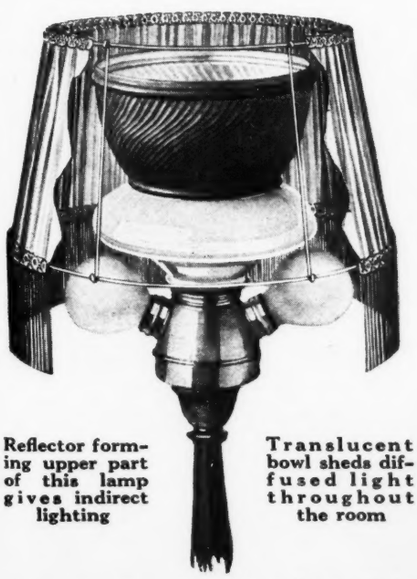
THE San Francisco fire department is making new efficiency records by having a specially constructed residence for the fire chief, making it possible for him to attend a fire as quickly as the engines.

When there is a fire, an alarm wakens fire chief and drivers, and automatically opens garage doors.

Lamp Attachment Provides Indirect Lighting

A NEW attachment for electric floor and table lamps makes it possible to obtain both a desirable diffused light throughout the room and the reflection of a brilliant light from the ceiling.

This indirect lighting adapter is provided with a screw that will fit into a socket in the top of the lamp, and is constructed of a translucent glass bowl surmounted by a reflector. When the adapter light is used,



Reflector forming upper part of this lamp gives indirect lighting

Translucent bowl sheds diffused light throughout the room

the lower bowl sends out a diffused light and the reflector sends light rays toward the ceiling.

With this new invention, any home can have indirect lighting, considered the best method of illumination from a hygienic point of view.

Origin of Righthandedness

THAT righthandedness developed when man began to use metal instruments during the so-called bronze age is the conclusion of Sarafin, eminent French archeologist, as the result of a study of implements used at various periods.

Bristles at Both Ends of Novel Toothbrush

A NEWLY invented toothbrush equipped with bristles at both ends, affords a means of cleaning teeth better than the ordinary brush.

The smaller brush is held in the handle by friction and can be removed instantly when it is desired to use the big brush. Thus it is kept from contact with the hand.

The small brush efficiently cleans the inner sides of the teeth and the surfaces between them.

Five Photos Are Taken on Same Plate

AN APPARATUS that photographs an object from five sides simultaneously, and on the same plate has been designed by the photographer of Johns Hopkins Hospital, Baltimore, Md.

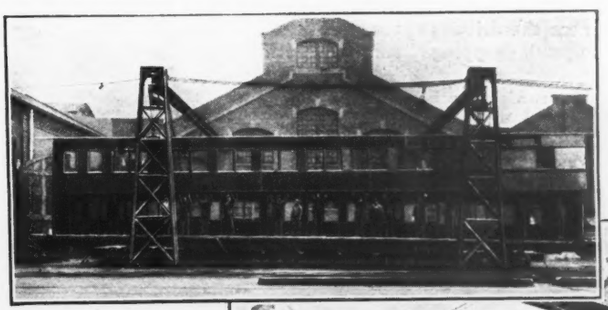
The object to be photographed is placed on the floor and the camera positioned so as to obtain a direct view. Mirrors are placed

By means of mirrors, top and sides of the object are photographed simultaneously

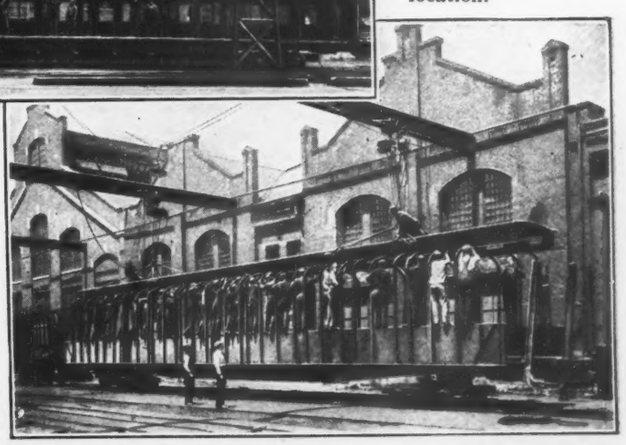
on the four adjoining sides of the object so that a direct view of each of the sides is recorded on the plate.

The finished picture consists of a central main view and four auxiliary side views. In the old way, five separate exposures were required.

Pullman Car Walls Built in One Piece



Sections are put together on the ground and hoisted into position by cranes and fastened there by gangs of workmen, who place the standards into their proper location.



BY BUILDING the longitudinal sections of Pullman cars in one piece, the manufacturers have added greatly to passengers' safety. Shop riveting is much more satisfactory than field riveting, it is found, with the result that the sections have a much greater power to resist impact.

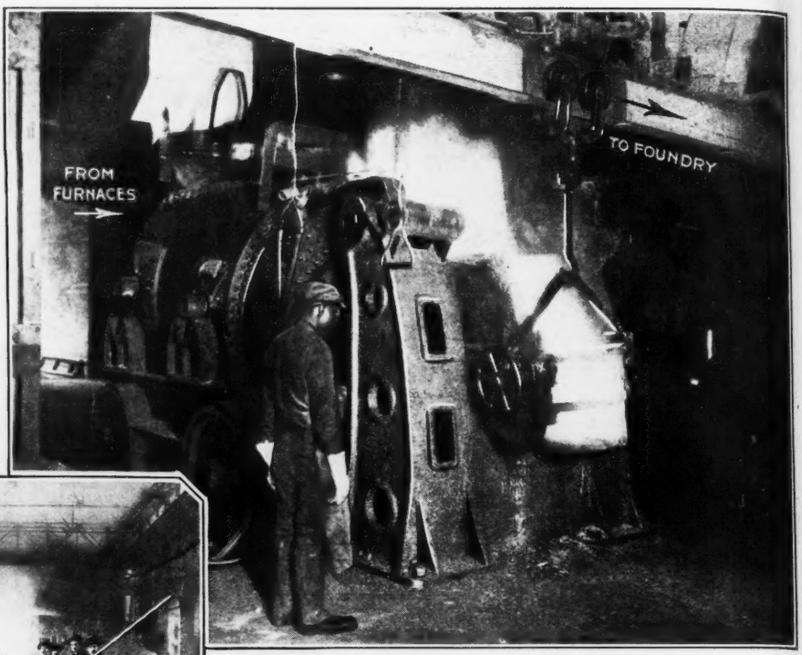
"Thermos Bottle" Holds Molten Iron in Ford Plant

TO ELIMINATE double heating of metal used in auto castings, the River Rouge, Mich., foundry of the Ford Motor Company employs a container, operating on the principle of a thermos bottle, in which the molten iron, coming from the furnaces, is maintained at white hot furnace temperature until the casting room is ready for it.

The usual method has been to cast the molten iron into pigs made up of the proper chemical composition. These pigs are melted a second time whenever it is desired to make castings—a duplication that results in considerable loss of time and labor.

The new container, with capacity of 25 tons, consists of one cylindrical shell within another, the inner one being lined with firebrick. At each end is an opening, one to receive the molten metal, the other to act as a spout in pouring the castings. The low conductivity of firebrick makes it possible to keep the iron at white heat for five hours, during which time the contents can be used up for castings.

The proper chemical composition of the metal is obtained by tests of the iron in the container. Since the ore is not uniform, it is necessary to "doctor" it after smelting. Thus if it is found that a batch contains too little carbon, the metal in the container is mixed with a precise amount of cupola iron of greater carbon content. The result is the desired chemical composition.



HOLDING molten iron at white heat until ready to be transferred to the foundry, the "thermos bottle" container shown above in Ford's River Rouge plant, represents a striking advance over the usual method (at left) in which the molten iron is cast into pigs. These pigs are commonly allowed to rust in the open, then they are remelted for casting. By the new method, molten metal enters one end of the container, and when wanted is poured from the other end into monorail buckets that carry it to the foundry

Sander for Motor Bus Stops Skidding

MANY of the accidents caused by the skidding of motor cars may be prevented by the use of a sanding device invented by August Schon, of New York City, and successfully tested recently on New York municipal passenger buses.

This anti-skid apparatus consists of a circular drum, attached to the under side of the chassis in front of each rear wheel. The drum holds eight hermetically sealed containers in each of which are three pounds of sand.

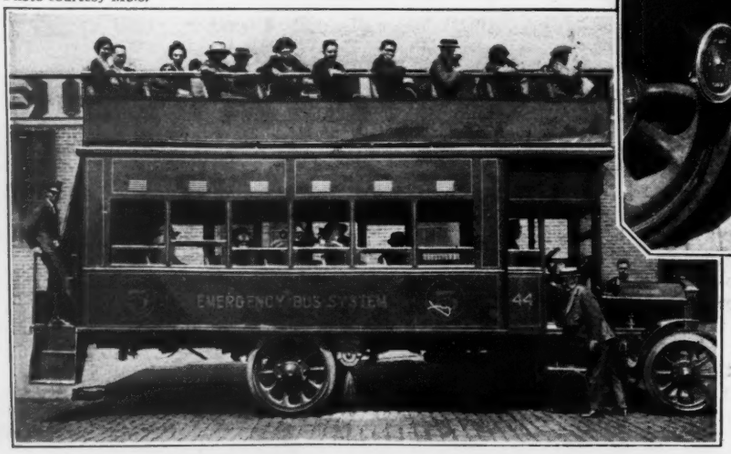
The tripping of a lever near the driver's seat releases the sand. The sand, dropping to the ground in front of the rear wheels, gives them an immediate grip on the road surface.

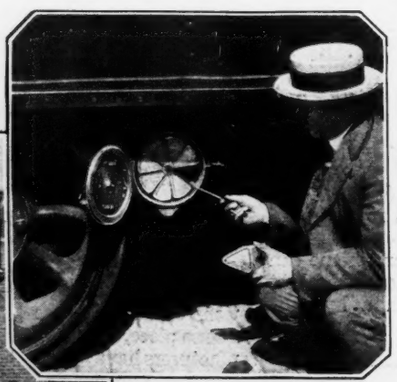
In fact, it is claimed that a bus carrying 40 passengers and equipped with the sanding apparatus can be stopped within three feet when traveling at a speed that would otherwise carry it nine feet with brakes set.

The apparatus can be attached to touring cars without interfering with the entrance to the tonneau, for the nine-inch drum can be mounted in front of the rear mudguard, the sand flowing through a hole bored in the runningboard beneath the drum.

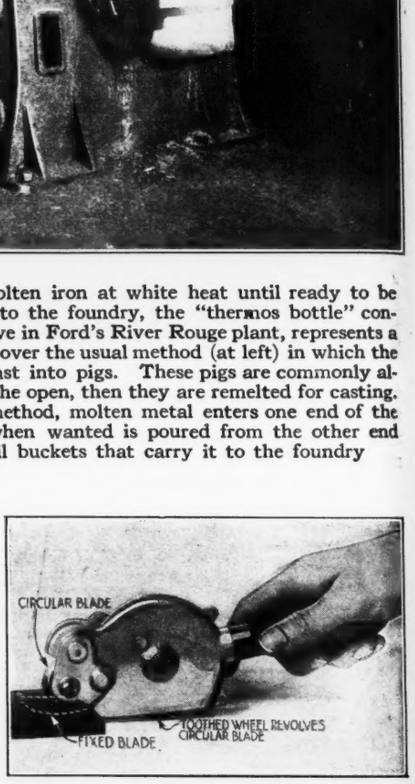
Tests with this New York municipal motor bus, carrying 40 passengers and equipped with the sanding device shown at right, showed that the sand, poured in front of the rear wheels, stopped the car within a third of the usual distance after the brakes were applied

Photo courtesy *Motor*





Attached beneath the chassis in front of each rear wheel, the sander consists of a cylindrical drum holding eight sand containers. A lever at the driver's seat releases sand from one container at a time



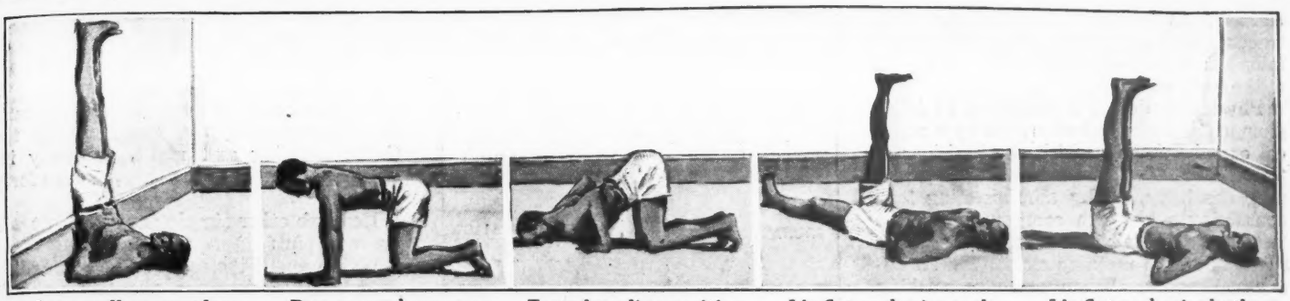
Rotary Scissors for Tailors

A NEW rotary cloth cutter, invented by John Holtzman, of Brooklyn, N. Y., has been designed to replace the shears as a cutting agent in large tailoring establishments, where it is said to turn out better work in shorter time.

It consists of a rotary cutter that presses, while rotating, against a fixed blade. This cutter is rotated by means of a toothed gear wheel, the lower part of which rolls along the surface upon which the cloth is laid.

Thus by grasping the handle and inserting the fixed blade of the tool under the cloth at the point where the cut is to start, then pressing down on the handle and moving in the desired direction, the operator can cut material in any pattern desired.

The new tool, while based on much the same principle as ordinary shears, is said to produce a cleaner cut.



Let a wall support legs as illustrated | Run around room on hands and knees | From kneeling position lower your chest to floor | Lie flat and raise each leg vertically | Lie flat and raise both legs vertically

Upside Down Exercises to Keep You Fit

Medical Expert Recommends Reversals in Posture to Stir Circulation of Stagnant Blood, Energize Under-Fed Nerves and Tone Sagging Digestive Organs that Have Grown Lax through Ages of Walking Erect

By Edwin F. Bowers, M.D.
Author of "Teeth and Health," etc.

IF YOU could hang by your heels or stand on your head a certain number of times every day, physicians now agree that you might guard against many annoying ills of later life, from which few of us suffered in childhood, perhaps just because we *did* stand on our heads or performed other similar feats.

The rather absurd looking, but really worthwhile exercises illustrated at the top of this page are urged upon us by health experts, to remedy the slumping of our internal organs caused by today's unnatural modes of living. The chief health benefits of thus figuratively "standing on our heads" are these:

It exercises blood vessels and stirs normal blood circulation through bodily tissues, thereby stimulating the natural processes of repair.

It puts elastic "tone" into the blood vessels of the brain, so that nutrition of the brain cells and elimination of waste become normal, and the maximum mental efficiency is achieved.

It tends to draw back into proper position abdominal organs that have fallen from their normal place.

Finally, it stirs to activity a vital, little known watery substance—the cerebro-spinal fluid—that should normally bathe the brain and circulate through the spine, but tends to become stagnant.

To the fact that we walk about on two legs, instead of running about on all fours, may be traced the ills that these exercises overcome. Indeed, when some apelike ancestor of ours, millions of years ago, first awkwardly elevated himself on his hind legs, thus first setting for mankind the fashion of walking erect, he sowed the seeds of a host of human ailments, although at the same time he made possible the development of our hands, brain, and speech—the sources of all civilization.

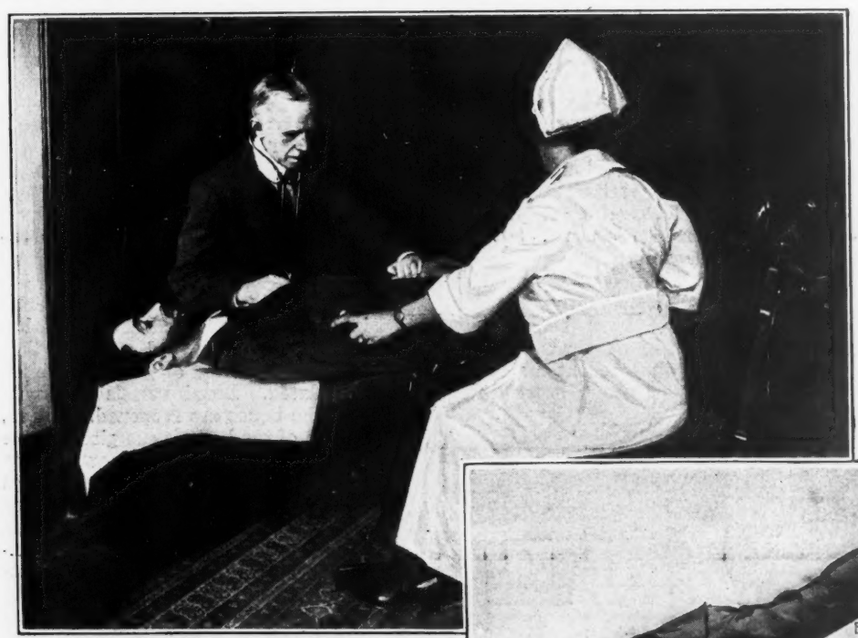
The erect posture changed the center of gravity of our internal organs, causing the stomach and intestines to hang unnaturally from the backbone, by tissues that have a tendency to relax, and let them sag downward into the abdominal cavity.

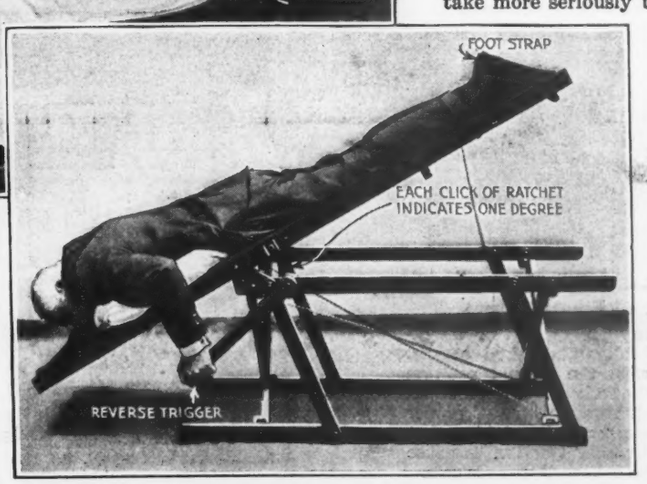
This relaxed condition, so doctors of all schools of medicine are now agreed, is responsible for, or contributory to, scores of the common ailments from which we suffer more or less all our lives.

A Source of Many Ailments

When we have "the blues," or a bad temper, or suffer from headache, dizziness, insomnia, nervousness in its thousand and one forms, indigestion, flatulence and obstinate constipation; when we wear a worried, haggard look; when our skin is sensitive to the touch, and either abnormally dry or profusely covered with sweat; when general catarrhal symptoms manifest themselves and bodily resistance to disease is lowered, we may be suffering from nothing more or less serious than this fallen state of the heavy organs of digestion.

If you will realize these facts, you may take more seriously than the average man does the various sets of exercises prescribed by physicians and physical culture experts—the phonograph record exercises now popular and the outdoor sports of golfing, swimming, and rowing. In fact, so important is the problem that an osteopathic physician of New York, Dr. William West, has recently invented a mechanical device called the "gravitiser," a gravity couch which, he





A Blood-Stirring Gravity Couch

SUPPLEMENTING the exercises shown at the top of the page, this tiltable table or "gravitizer" has been devised by Dr. William West, osteopathic physician of New York City, to relieve ailments traceable to our failure to exercise blood vessels and bodily organs by varying our postures. Lying outstretched, as shown above, the patient's body is inclined head downward for a specified period. This movement the patient himself may control by means of a lever with adjustments providing for 40 different degrees of inclinations

claims, relieves many ailments that may be traced either directly or indirectly to our failure to exercise blood vessels and organs of the body by varying our postures.

Physicians detect a condition of fallen stomach and abdominal organs by a medical examination in which the positions of the abdominal organs are outlined by tapping the body, or by administering food containing a bismuth compound. In the latter case, X-ray photographs show the shadows of the metallic element in an abdominal cavity. When we suffer a falling of the intestines, the liver, spleen, and kidneys are usually also involved, complicating the situation by becoming sluggish. Thus it is that bowels lose their "tone," slowing up the wormlike motion of the muscles of the intestinal walls that finally pass intestinal debris out of the system, permitting the accumulation of quantities of waste matter in the bowels. This in turn results in the absorption of poisons developed by decomposition of the accumulated matter.

Causes of Falling Organs

A general falling of the organs (called "visceroptosis"), involving the large nerve network, or nerve center, in the abdomen—second in importance only to the brain itself—may produce any one of a wide variety of diseases.

Falling of the stomach and abdominal organs occurs among all civilized peoples. Among its causes are the wearing of corsets, girdles, and other clothing that distorts the body; improper breathing, sedentary habits and lack of exercise, inadequate rest, high heeled shoes, overeating, overdrinking, excessive use of tobacco or other narcotics and stimulants, or plain worry.

In extreme cases of falling of the stomach and abdomen, the bowel, instead of slipping down like a solid structure, collapses upon itself as if it were a wet cloth thrown into tubular form, creating folds, creases, and wrinkles that frequently cause acute illness or chronic distress. Even the normal person may realize in a degree the effect of a falling abdomen or stomach. Let some one stand behind you, raise your abdomen and support it for a few moments. You will experience a feeling of lightness and buoyancy vastly different from the dragging, heavy sensation that follows when the lifting support is removed, and the abdomen is permitted to sag into its usual, but unnatural position.

In addition to the exercises of stooping, twisting, and turning that have been recommended by physical culture experts, an excellent method of strengthening the abdominal muscles, and one that any person can practice easily, is this:

Lie flat on the floor and slowly raise your feet and legs until they form a right angle with your body; then slowly lower them, at first repeating the exercise only ten times, morning and night, gradually increasing the number to thirty, or even forty times.

Here are other simple exercises that will prove helpful:

Walk around the room "on all fours."

At intervals assume the "knee-chest" position—that is, while in a kneeling position on a bed, turn your head to one side and lower your chest to the bed.

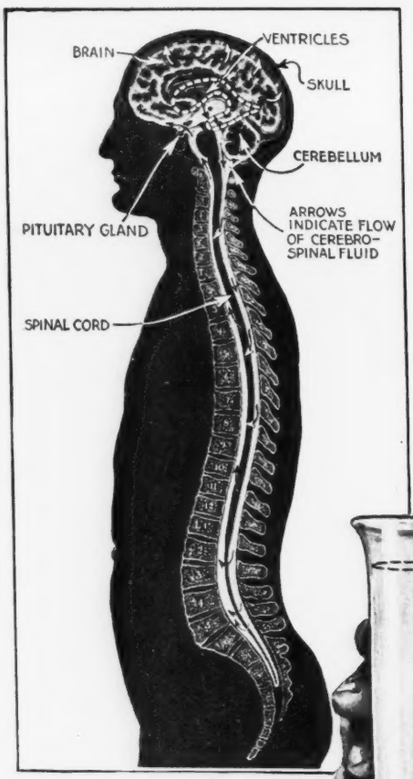
Lie with knees flexed and massage your abdominal organs, always taking care to force the organs upward.

Supplementing such exercises as these is the gravity couch, or tiltable table, upon which the patient lies outstretched, and by means of a lever inclines his body, head downward. It is equipped with adjustments to provide for 40 different degrees of inclinations that progressively increase the influence of gravity on the body, one degree at a time.

The device makes use of the principle that the blood in the human body, since it is inclosed in elastic and nerve-controlled tubes, is not instantly influenced by gravity when the position of the body is reversed, but responds only after the lapse of five seconds. Thus, because the walls of the blood vessels do not release their tension until five seconds after the patient's body is inclined, the device may be used safely within that time, to exercise the blood vessels and bodily organs to the limit of their endurance.

In whatever portion of the body the blood flows, or can be made to flow, by gravity, the natural processes of repair are stimulated; for this flow restores circulation in tissues where blood circulation has been feeble and inactive. Nerve cells that may have been starved or poisoned are fed and stimulated. Blood vessels in remote canals of the bones are reopened. Indeed, every organ of the body is energized by the flow of blood through it. Meanwhile, the tilting of the body backward swings the stomach and abdominal organs back into their normal positions and tends to maintain them in these positions by strengthening the supporting tissues. It is claimed that the blood vessels of the brain are thus exercised, tending to relieve depression, and restoring mental efficiency.

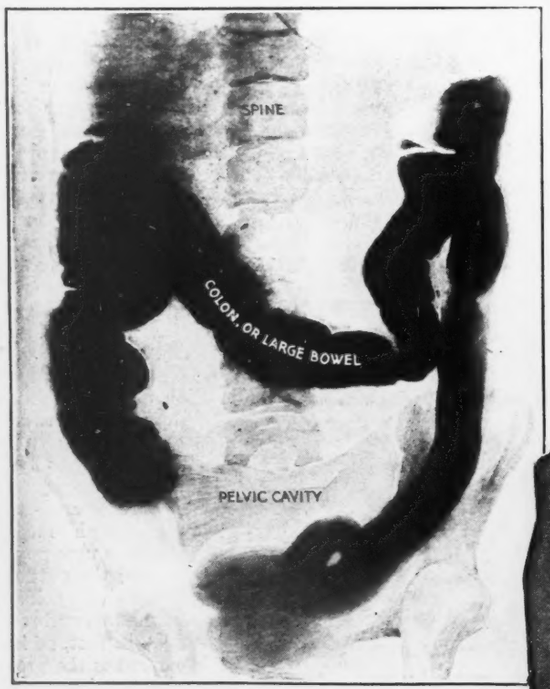
Finally, the watery fluid that bathes the brain and spinal cord is stirred into activity. Remember that our spinal cord and brain are entirely surrounded by this cerebrospinal fluid. Exercises such as suggested in this article, stimulate the normal activity of this life fluid in the brain and spinal column, thus helping to banish disease, strengthen resistance, and increase our good spirits and efficiency.

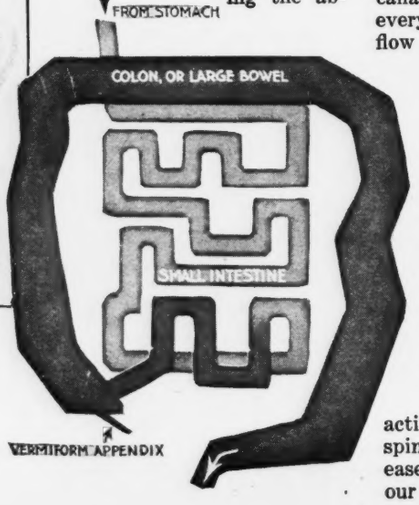


A Health Giving Fluid

Showing how the cerebrospinal fluid, possessing mysterious health-giving properties, normally bathes the brain and spinal cord. Unless stimulated by exercises, this fluid stagnates, causing mental and physical depression

In health, your body should contain about 80 cubic centimeters — about two tenths pint — of cerebro-spinal fluid. A serious excess may cause illness

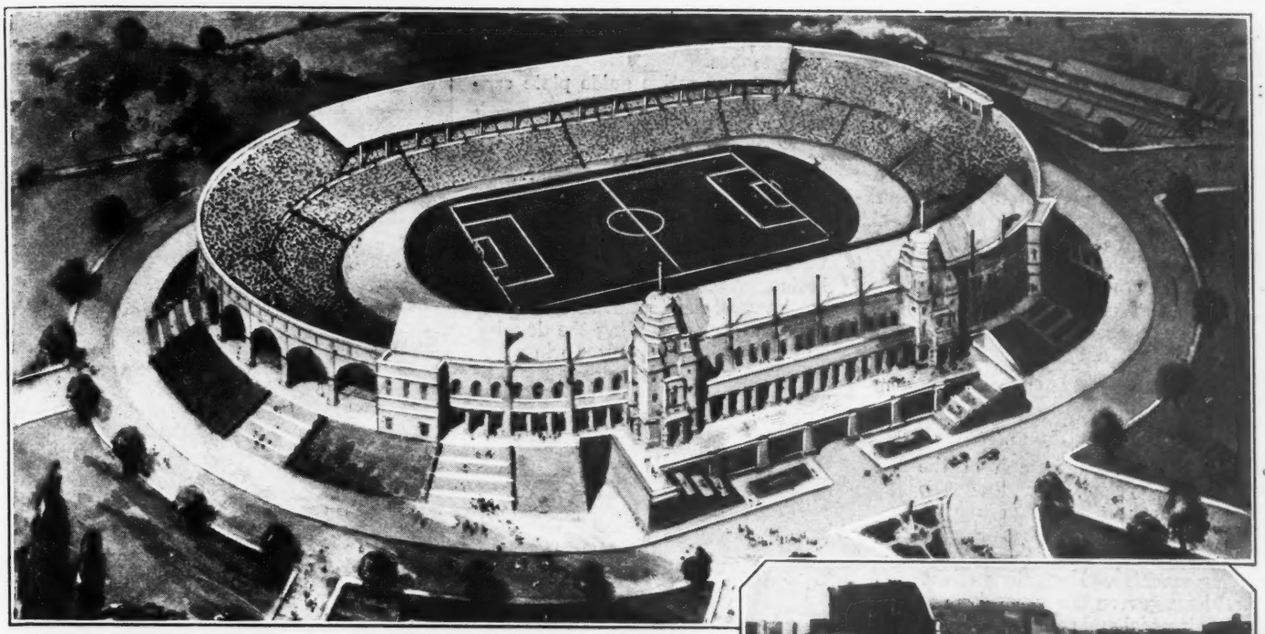




One Result of Erect Posture

THE above X-ray photograph of an extreme case of fallen abdominal organs. When compared with the normal position diagram at right, shows how the large bowel collapses upon itself through lack of proper exercise, creating creases and wrinkles that clog the abdominal passages and often cause acute illness by the accumulation of waste

Mammoth Stadium Will Hold Babe Ruth's Longest



This modern super-amphitheater, the Imperial Stadium at Wembley Park, near London, will accommodate 126,000 spectators—80,000 more than did the ancient Roman Colosseum, shown in ruins at the right

THE Roman Colosseum, which stood for centuries as the greatest amphitheater in the world for the presentation of sport spectacles, is to be dwarfed by two huge modern stadiums, one of which will accommodate three times as many persons, while the other will have twice the capacity.

They mark a double climax to the two decades that have passed since dedication of the Harvard Stadium in 1903, and that have witnessed construction of the Yale Bowl, the monster stadium at Ohio State University, and numerous other outdoor theaters for the athletic spectacles of which the American public is so fond.

The greatest arena of modern times will be England's Imperial Stadium now in construction at Wembley Park, near London. It will accommodate 126,000 persons, all of whom will have a clear, unobstructed view of the playing field, although only 35,000 will be seated. In actual seating capacity this British amphitheater will be surpassed by the new American League baseball stadium in New York, now nearing completion, which will seat 85,000 persons for baseball games, and perhaps 15,000 more for football, fights, or other athletic exhibitions.

The Colosseum, most famous of all structures used for gladiatorial spectacles in the days of Rome's glory, accommodated about 45,000 spectators, according to estimates, although not more than 30,000 were seated.

The new Wembley stadium, which will be the center of all great English national athletic contests, and perhaps the site for the Olympic games, will cover 2½ times as much ground as the Colosseum. The outer wall will be half a mile in circumference.

The American League stadium, seating more spectators than any structure in the world, will cost $2,000,000. The field alone would hold two of the arenas in which gladiators amused the Roman public in ancient days.

No chance for Babe Ruth to knock a ball "out of the lot" in the new baseball stadium of the New York Yankees, shown above. This is now the greatest of modern amphitheaters, seating 85,000 spectators for baseball games and 100,000 for other athletic contests

Improved Photo Sculpture Creates Masterpieces

SURPRISING simplifications of the English invention by which a specially taken photograph is reproduced in bas-relief on alabaster, ivory, or wood, have been made since the photo sculpture machine was first described in the October issue of POPULAR SCIENCE MONTHLY. By increasing the accuracy of the process, the new improvements have achieved astonishing perfection in detail, as shown in the photo bas-relief on this page.

It will be remembered that in the method described in POPULAR SCIENCE MONTHLY a beam of light is projected from a magic lantern on a person's face or on a statue to be reproduced, a lined glass plate being used in the lantern in the place of an ordinary slide. This glass plate projects spiral lines, like those of a phonograph record, on the subject to be reproduced. A photograph of the subject is then taken, and on this photograph the spiral lines appear. From the negative, a print is made on opal glass, which is used to guide the carving machine. Deviations of the spiral lines govern the movements of the cutting tool and so reproduce the photograph in bas-relief.

Glass Negative Guides Tool

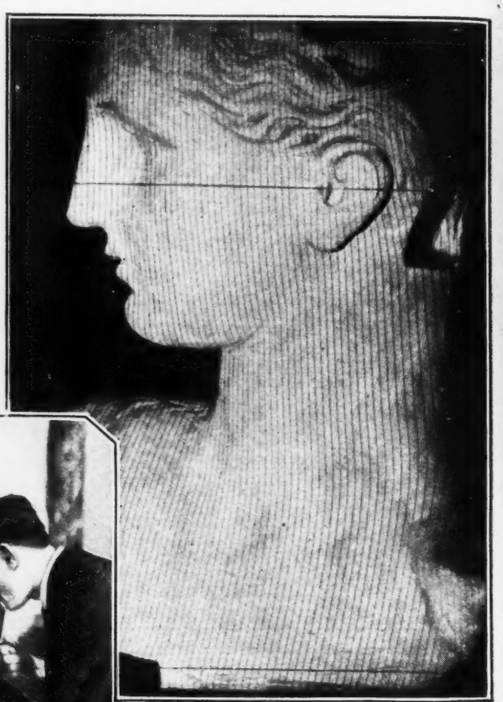
The improved machine works on a similar principle, except that parallel lines instead of spiral lines are used, while instead of the opal glass print, the glass negative itself can be used to guide the cutting tool.

Mounted on a massive, sloping bed plate, the new sculpturing machine is operated by two electric motors. A horizontal motor drives a sliding frame that carries the carving tool and moves on a horizontal plane over the material to be carved. The other motor, mounted above the cutting tool, rotates it at high speed.

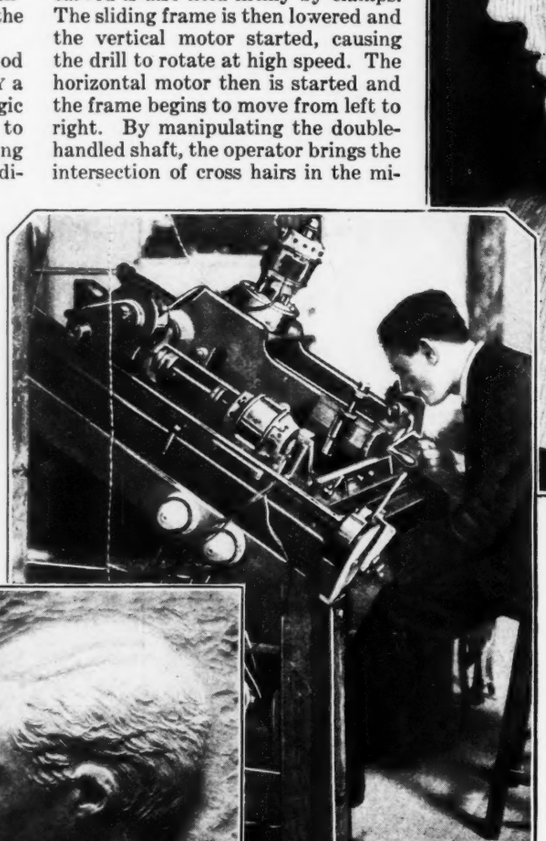
A two-handled control shaft is geared both to the vertical shaft on which the cutting tool is mounted and to the sliding frame, which carries a pair of micorscopes.

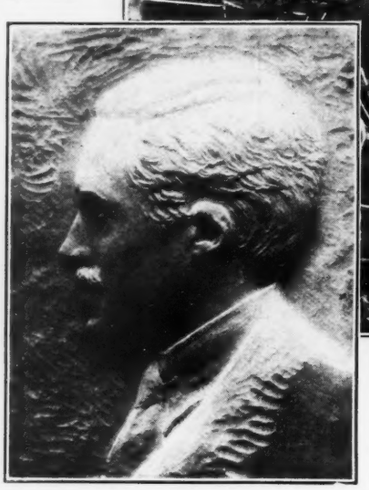
After a negative guide plate containing parallel guide lines is made, the sliding frame is swung upward, and the negative plate is clamped to the bed plate, and the material to be carved is also held firmly by clamps. The sliding frame is then lowered and the vertical motor started, causing the drill to rotate at high speed. The horizontal motor then is started and the frame begins to move from left to right. By manipulating the double-handled shaft, the operator brings the intersection of cross hairs in the microscope over the end of one of the lines on the negative plate and maintains it on that line to the end of the cut.

Since the microscope and drill move in unison, every transverse deviation of the line from the straight results in a deeper or shallower cut of the drill. The operation is repeated on every line.



Above is a negative used in carving a sculptured reproduction from a photograph. Parallel lines guide the cutting tool





The remarkable bas-relief, at left, carved from a photograph by the improved sculpturing machine shown above, gives evidence of the beauty and precision of the new process

Making Bronze Bas-Reliefs

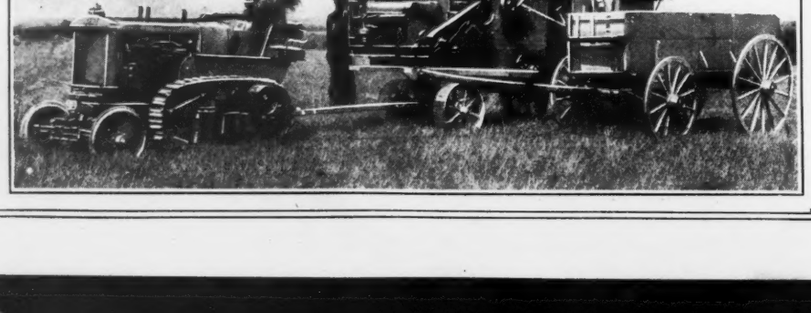
At the end of each cut, the drill is raised, the motor reversed, bringing the frame back to position.

For a bronze bas-relief, a plaster cast of the machine carving is made, upon which the metal is electrolytically deposited.

Small Thresher Saves Time for Farmer

A NEW small thresher that sells at a price within easy reach of the small grain farmers, should prove a great time saver, for with it the farmer can follow up the reaper, thresh his grain immediately, load his wagon with the grain, and scatter the straw about the field to be plowed under as fertilizer.

A tractor draws the thresher about the field and the grain wagon is hitched alongside. Should it be desired to save the straw, the machine can be operated as a stationary engine.



Radioactivity of Bottled Water Is Negligible

NONE of the foreign or domestic commercial bottled water sold to consumers on the claim of radioactive content really contains sufficient radioactivity to warrant its purchase, according to the report of investigations completed by the water and beverage laboratory of the United States Department of Agriculture, Washington, D. C.

In the examination of 46 samples from 15 states and eight foreign countries, the bureau found the highest quantity of radioactivity of a temporary nature in a bottled water from Massachusetts.

The largest amount of permanent radioactivity was in a sample from a deep well in Ohio. It was found, however, that it would be necessary to consume 2810 gallons of the Massachusetts water, or 1957 gallons of the Ohio water daily to obtain an efficient dose of radioactive salts.

During the tests radioactivity of samples was determined by means of electroscopes.

Secrets of Successful Auto Driving

How to Shift Gears Noiselessly—Other Useful Tips from an Expert

By Harold F. Blanchard

HOW many automobile drivers are satisfied with the way they shift gears from high to second or from second to low? Do you know how to make the most effective use of the appliances on the dashboard and of the levers at your side? And do you know how to safeguard yourself and your car against the chance of accident—a disturbing chance that continually hovers over the average motorist (whether he is aware of it or not)?

There are a hundred and one little tricks of successful driving that a veteran motorist learns, sometimes by bitter experience; and it is my purpose this month to pass some of these tips along in the hope that they may steer you away from common pitfalls and so increase your enjoyment and safety in driving.

Can You Shift Down?

First, consider the gearshift. Most motorists can slide from low to second and from second to high without a clash and without interrupting the motion of the car; but when it comes to shifting down—that's quite another matter. In fact, it's one of the most difficult problems of successful driving, particularly in hill climbing, and one that comparatively few drivers have mastered. The steeper the hill, the more difficult the problem becomes.

Right here I want to let you into a secret of gear shifting that has worked so successfully for me and for others who have tried it that it is worth passing on. I learned this secret from a motorist whom I met back in the hills of Vermont, and it's so simple, the wonder is that everybody hasn't tumbled to it.

Until I struck some of those grueling Vermont hills, I hadn't given much thought to uphill shifting. Like the majority of motorists, whenever I had to make a shift down, I shut my eyes, gritted my teeth, and yanked the lever. Sometimes I made a lot of noise, which I knew meant that I was chipping little pieces off the gear teeth; and often I lost considerable momentum. But on those terrific back road hills it was a question of quick and sure shifting, or the risk of breaking your neck. In short order I learned how to shift quickly, but I was still noisy about it, until I was taught the simple trick, which is this:

Speed the Engine—then Shift

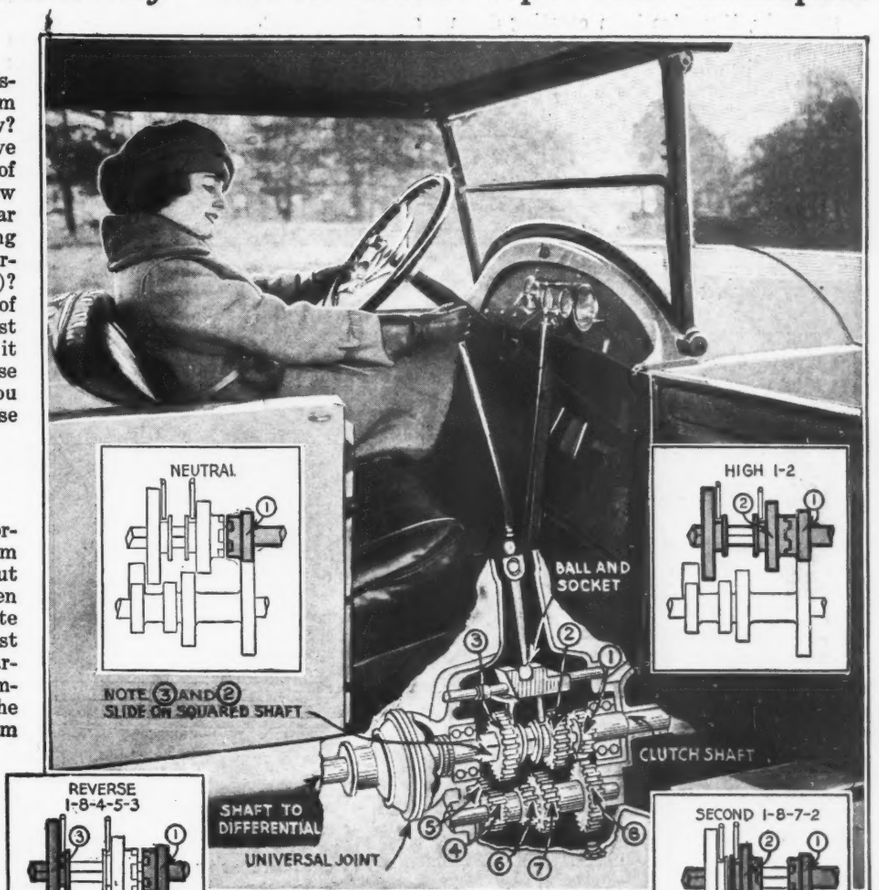
Suppose you're climbing a hill that is a little too steep for high gear. When you are about halfway up, you realize you must shift to second. The throttle is wide open. You know, in general, that to make a silent shift from high to second, from second to low, or from high to low, you must increase the speed of the engine approximately to the rate demanded by the lower gear. But how? Here's the answer:

Hold the throttle wide open and depress the clutch just enough to allow the engine to speed up the desired amount—THEN SHIFT.

You can perform the entire operation in almost the time it takes to snap your fingers. You can't go wrong, and if you judge your engine speed with even fair accuracy, your shift will be absolutely silent. The clutch is out for such a brief instant that the loss of momentum is negligible. I have shifted from second to low by this method on a 30 per cent grade without noise and with no noticeable loss of speed.

If a down shift must be made on a slight up grade, down grade, or level, you need not open the throttle wide. A good rule is to hold the throttle pedal just where you have had it. In shifting from high to low, remember that the engine must be sped up much more than if you were shifting from second to low. Also remember that while 20 miles an hour is a moderate speed on high, it is a terrific speed on low. It is entirely safe to shift from high to low at from 15 to 20 miles an hour, provided you speed the engine up enough. In any case, too much engine speed is better than too little.

I've observed that many drivers, when shifting upward, are puzzled as to what to do when they wait too long, missing the gear. After trying to effect an engagement by clashing, they stop the car and start over again. There is an easier method. If you're shifting from second to high, for



Move the gear lever with assurance, neither slowly nor with panicky haste

Be sure that the gear is fully engaged before engaging the clutch

Here's What Happens When You Shift Gears

THE picture and diagrams above illustrate what goes on inside the transmission when you move the gear lever for the various gearshifts. The main numbered diagram shows the entire transmission gear mechanism as assembled in the ordinary car, while the small diagrams, numbered correspondingly, show the gear positions for various shifts.

Gear 1 is connected with the rear end of the clutch shaft and always rotates with it. Gears 2 and 3 are mounted on the main shaft, which is connected through a universal with the drive shaft. Gears 4, 6, 7, and 8 are mounted immovably on the countershaft and always rotate with gear 1, while gear 5 is mounted on its own little shaft and is always in mesh with 4. Gears 2 and 3 are the "sliding gears" that are moved by the gear lever. They slide on the drive shaft, which is square or splined. Splines are simply keys integral with the shaft.

For high gear, 2 is moved forward and engages gear number 1. Thus the clutch shaft and the drive shaft rotate as one, and "direct drive" is obtained.

For second gear, 2 is moved back into mesh with 7 and the power passes through gears 1, 8, 7, and 2.

For low gear, 3 is moved forward to mesh with 6, and the power passes through gears 1, 8, 6, and 3.

For reverse, 3 is moved into mesh with 5, and the power passes through 1, 8, 4, 5, and 3.

example, and miss high, immediately slip the lever to neutral, engage the clutch, and speed the engine up to a point somewhat beyond that demanded by high gear; then shift as if nothing had happened. Logical, isn't it?

Similarly, if you've been coasting down a long hill with shift lever in neutral and engine idling, when you get to the bottom, speed the engine up above the high gear rate before shifting. Unless you do this, you may have trouble engaging the gears.

If you coast down a hill with lever in neutral and engine shut off, there is no way of getting back into gear so that the momentum of the car may be used to start the engine. The engine must be brought into motion with the electric starter.

When Engine Is Shut Off

If you wish to coast with engine shut off and yet do not wish to use the starter, be sure to leave high gear engaged, coasting by holding out the clutch. At the bottom of the hill engage the clutch gently, with the switch on and the throttle closed, so as not to strain the mechanism.

In using the engine as a brake, it makes little difference whether the switch is on or off; but if you run with it off, be sure to keep the throttle closed, not only to save fuel, but also to avoid muffler explosions when the switch is turned on.

When driving down a long hill, use second gear in order to keep your brake linings from burning. This advice applies to all cars with service and emergency brakes acting on the same drums. If the brakes are on different drums, it will probably be sufficient to use the brakes alternately for about an eighth of a mile at a time. On the Ford, use the service brake and reverse pedal alternately.

Mud a Cause for Worry

Don't attempt to drive on snowy or icy roads without chains applied to the rear wheels. Look out for slippery, muddy hills in traversing unknown side roads in mountainous country.

When driving on unknown roads, mud is really the only thing to worry about. Sand or stones or severe bumps all may be negotiated successfully, even though some time may be lost; but it takes more than slow driving to combat deep mud. Chains will be required on the front wheels for steering, as well as on the rear wheels for traction. If no chains are available, remember that any farmer can supply you with hemp rope from three quarters to one inch in diameter, which will serve the purpose.

In the deepest mud even chains and rope are useless, but a special device, known as a "mud hook," is made just for the purpose. It is of metal, with a broad base that is chained to the tread of the tire. Mounted crosswise on the base is a metal cleat two inches high. With two of these hooks on each rear wheel, your car can walk out of almost anything.

To get through a short stretch of deep mud, or even a single deep puddle, just "keep going," using second or low, as required. If the car stops, don't spin the wheels, or you are likely to get mired to the hubs. Back out of the mud gently but firmly. Then take stock of the situation. Detour if you can; put on chains, ropes, or mud hooks if necessary; inspect the road for an easier path; and, finally, if you must follow your original tracks, do so with all the speed you dare. If you stop again, back up and buck it again, and so on.

The safest ride I ever enjoyed was with a race driver, and some of the most dangerous rides have been with motorists who thought they were being "careful." I believe there is no such thing as an unavoidable accident. True, there are plenty of accidents in which two cars are involved in which one driver is absolutely innocent; but never have I found a case where both drivers really did everything in their power to avoid an accident. Doesn't the appalling increase in automobile accidents emphasize the need of education for the driver?

Let's consider a few instances where accidents might have been avoided easily:

"A" swings around a corner at a fair rate of speed while a pedestrian walks into his path. Instead of slowing down, "A" presses the horn button to shoo the man out of the way; but the horn fails him.

Local Rights of Way

"B" approaches a road intersection at a fair rate of speed. He has the lawful right of way. But at the same moment another car, piloted by a stranger who doesn't know the local law, approaches on a side road. "B" stands on his rights and there is a collision.

"C" drives 15 miles an hour — the lawful speed — down a street crowded with playing children. One of them gets in his way. He tries to stop, but it is too late. Ten miles an hour would have prevented the accident.

"D" is running 40 miles an hour when his right front tire blows out. The steering wheel is jerked from his grasp and the car turns over. A tight hold on the wheel would have prevented the accident.

Horn Prevents Disaster

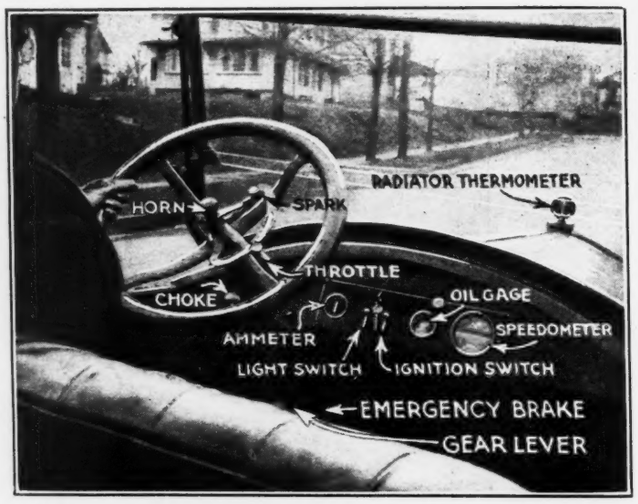
"E" is driving at a moderate pace along a country road. He dims his lights for an approaching car and then runs over a man walking at the side of the road. Blowing his horn at the moment would have prevented the calamity.

It must be admitted that better brakes might prevent a large percentage of accidents. The braking equipment on most cars is sadly deficient. But it is difficult to imagine an accident that might not have been avoided by exercise of caution.

The trouble is that most motorists drive with little or no "factor of safety." If this term is new to you, I might explain by saying that an elevator cable is usually made 10 times as strong as the calculated maximum stress; thus the factor of safety is 10. In machines where life is not endangered by possible breakage, it is usual to allow a factor of safety of five. The factor of safety is a necessary precaution to allow

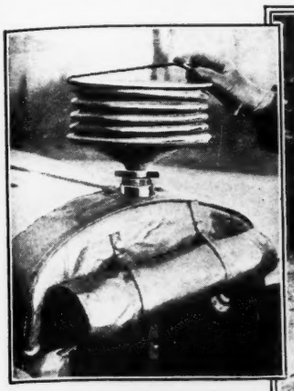
(*Continued on page 45*)

At the Wheel—What to Do and How to Do It

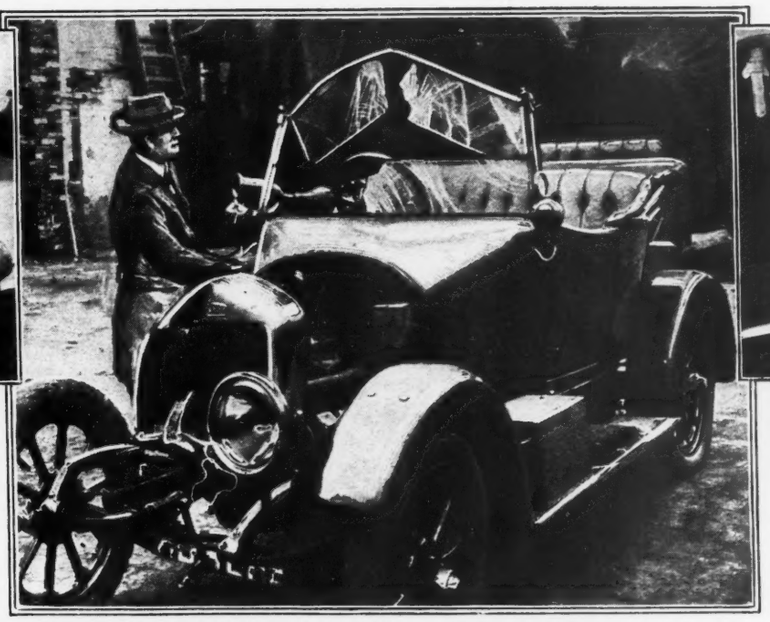


Choke	Don't forget to push the choke in after the engine has started; otherwise the engine will suck in raw gasoline that will prevent proper lubrication.
Light Switch	Be sure to turn lights off when you put the car away. Never leave headlights on when the car is standing, but have at least one light burning front and rear to prevent collision.
Ignition Switch	When you attempt to start the engine, be sure to turn the switch on all the way.
Ammeter	Form the habit of watching the ammeter measuring the current from the battery. When it fails to work, find out why as soon as possible and avoid battery trouble.
Oil Gage	Watch the oil pressure gage. Operating the engine when the gage fails to register will usually result in burned out bearings.
Speedometer	Be sure that your speedometer is accurate. At least twice a year ask some motorcycle officer to pace you for a hundred feet or so.
Gear Lever	Before starting the engine, always be sure the gear lever is in neutral.
Emergency Brake	After the car is under way, try the emergency brake to see that it is off and so avoid burning out brake lining.
Spark	Drive with spark fully advanced, retarding it only to prevent knocking when the throttle is opened wide with engine running slowly. Retard spark half way when cranking.
Throttle	Open the throttle from one eighth to one quarter for starting.
Horn	Never "drive with your horn." Don't depend on it. It may fail you when you need it most.
Radiator Thermometer	When the thermometer indicates an overheated engine, get out and see what's wrong.

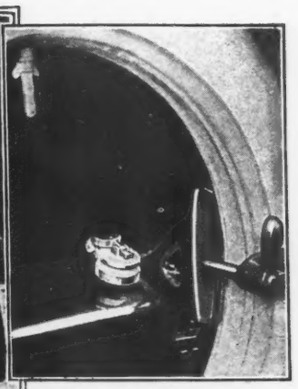
Novel Auto Accessories for Safety and Comfort



The neck of this 2½-gallon folding bucket for filling the radiator has an automatic valve that opens when resting on radiator pipe

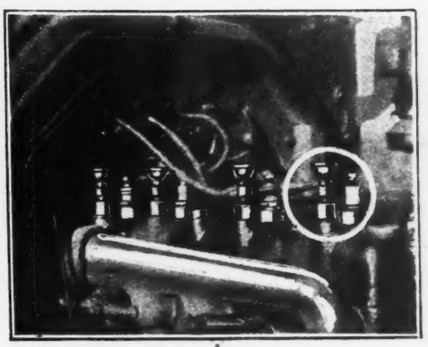


Because this windshield, against which a motorcycle rider was hurled, was of a new type of non-splintering glass, the occupants were uninjured



A newly devised spring hinged gasoline tank cover cannot be lost and provides added safety against explosion by releasing vapors generated by excessive heat

A new leather spring cover contains an oil hole equipped with dustproof spring cap, and provides efficient lubrication



New priming cups, mounted on four special head bolts and installed in an hour, facilitate starting of Fords

This instrument simplifies headlight focusing by projecting the rays on a ground glass screen

(*Continued from page 44*)

for flaws, lack of uniformity in the strength of material, unexpected stresses, wear, and rust.

But most motorists drive as their whim dictates. They fail to make allowances for lack of experience, lack of alertness, unfamiliarity with the roads, recklessness of other drivers, faulty brakes, or unexpected developments. As long as conditions remain ideally favorable, they skim through, but sooner or later they run into trouble.

It is advisable to be twice as careful as you think you ought to be, simply because it is impossible for any human being to be fully alert every instant that he is behind the wheel. No matter how good a mind he has, it will wander. Hence the constant need for alertness as a factor of safety in driving.

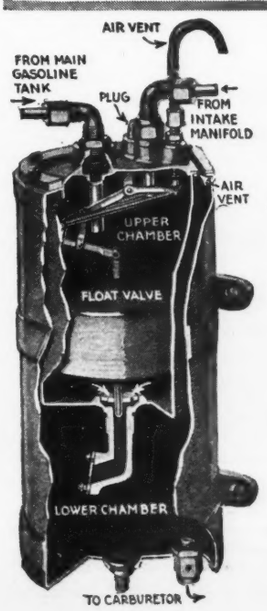
To maintain a proper factor of safety at all times, we must view our driving pessimistically. When on the road we see a smashed car and its victims, we are kidding ourselves if we say, "That will never happen to me." We should never think of taking a chance if we thought that we might suffer for it the very next instant. The attitude that we can take a chance once in a while and get by with it is wrong. Just as wrong as that of the motorist who believes in his luck. We can't monkey with the law of averages and get away with it. The more chances we take, the surer we are of having an accident. The only way to be safe is to drive always with an extra dose of caution.

I've found that it takes imagination, experience, and unending alertness to drive safely mile after mile. In order to drive safely, we must learn to recognize crises of all sorts far enough in advance to take whatever steps are necessary to avoid them.

New drivers will do well to be especially cautious until the trio—imagination, experience, and alertness—are fully developed. Finally, here's a mighty good rule to follow:

Never outdrive your headlights or your brakes.

Know Your Car

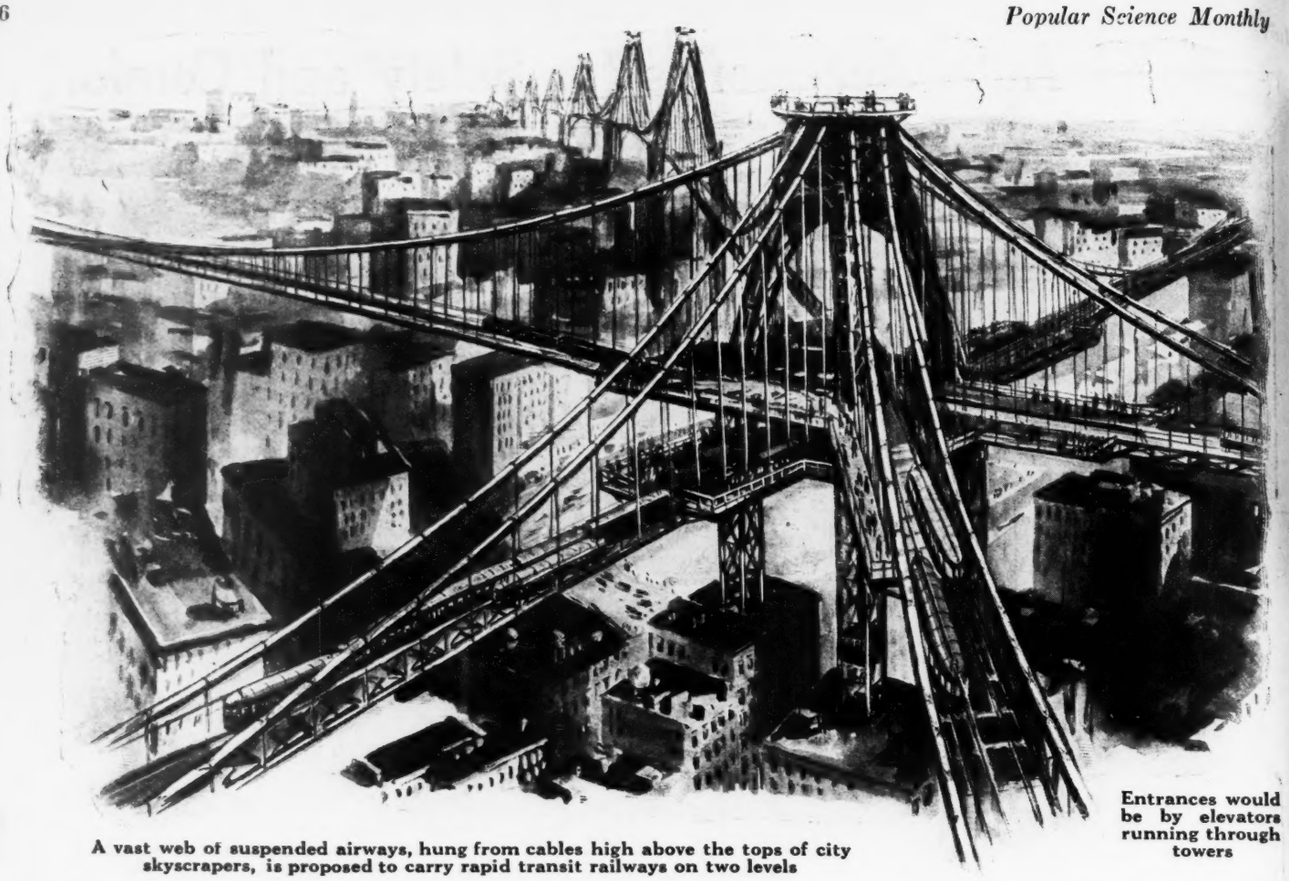


The Vacuum Tank

THE function of the vacuum tank is to draw fuel from the gasoline tank and deliver it to the carburetor, utilizing suction from the intake manifold. The tank incloses two chambers, a float, and valves. In the upper chamber are intake pipes connecting with gasoline tank and intake manifold, while an outlet pipe in the lower chamber runs to the carburetor.

When the float is at the bottom of the upper chamber, as in diagram, the valves controlling the gasoline pipe and suction pipe are open, and the upper chamber fills with fuel. Thereupon the float rises, closing these two valves and opening an air vent. The fuel then flows through a one-way flapper valve to the lower chamber, thence to the carburetor.

As the upper chamber is emptied, the float drops and the cycle is repeated.



A vast web of suspended airways, hung from cables high above the tops of city skyscrapers, is proposed to carry rapid transit railways on two levels

Entrances would be by elevators running through towers

Proposes Suspended Railways to Bridge Cities!

CONFRONTED with traffic problems that seem beyond solution under present conditions, faced with ever increasing streams of automobiles, and impressed with the need for adequate rapid transit, authorities of greater American cities, especially New York, are desperately trying to find some way to meet the situation.

How will these critical problems of transportation be met eventually—*on the surface of our streets, underground,* or *above us?*

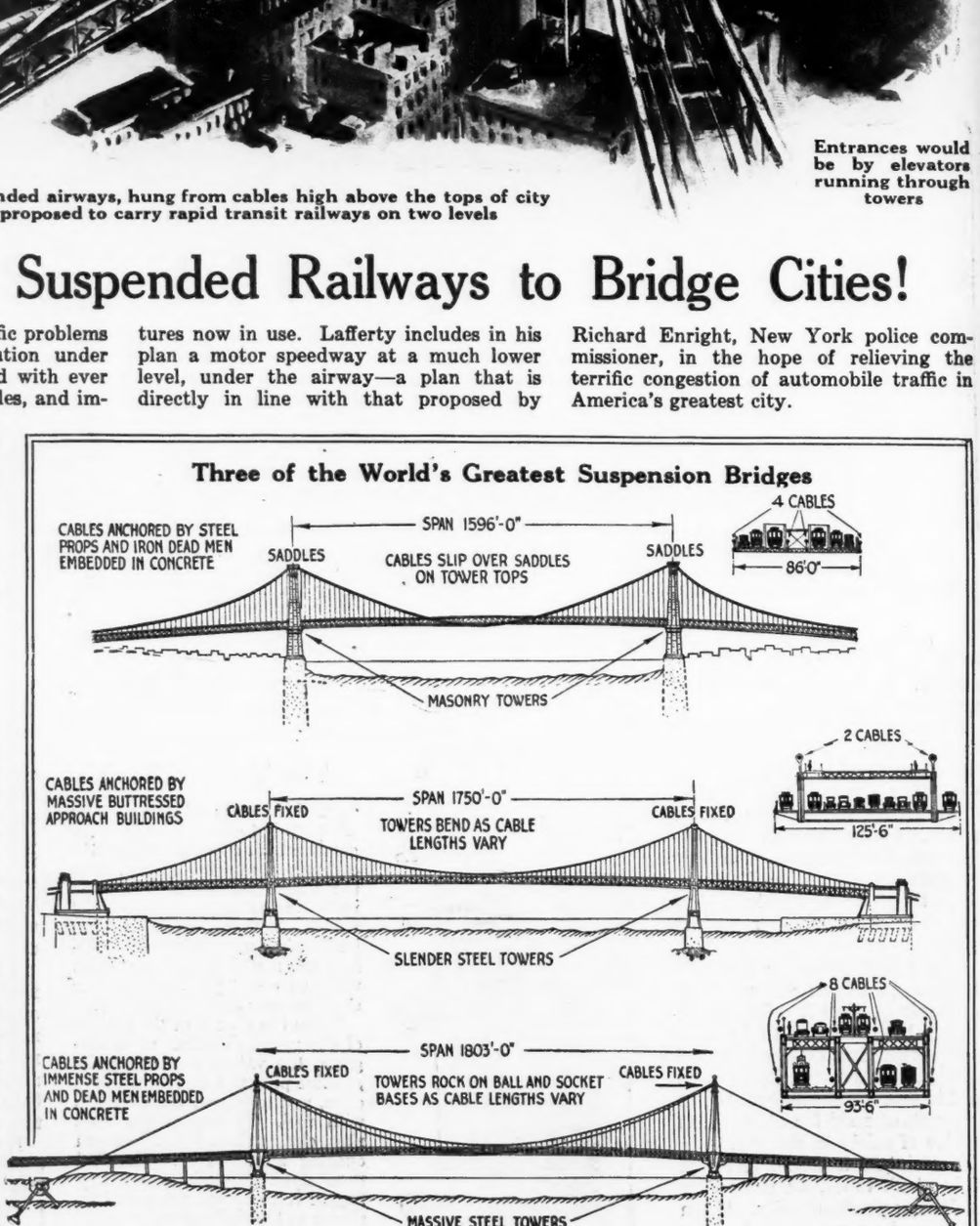
An Expert's Prophecy

Gustav Lindenthal, designer of the world's greatest railroad arch bridge and of the colossal suspension bridge that will span the Hudson River, declares, in a signed article on the opposite page, that the century in which we live will be the final chapter in the greatest era of iron bridge construction in history.

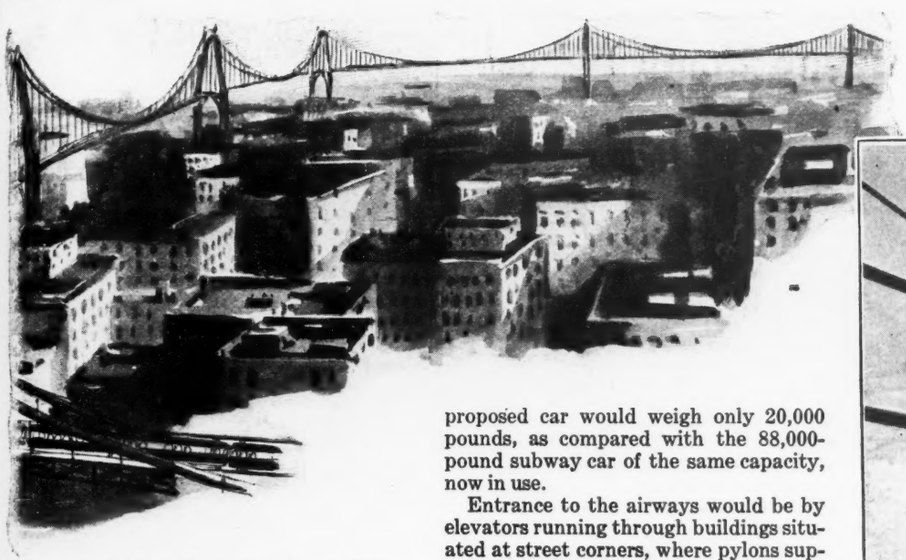
Is it possible that the last word in suspension-cable steel bridges will be a vast network of hanging airways, carrying trains of an aerial rapid transit system high over skyscraper roofs out to the commuters' suburbs?

Just such a system of aerial transit actually has been projected by R. C. Lafferty, New York engineer, and is now being considered by the New York Transit Commission to supplant, to some extent, the subways and elevated structures now in use. Lafferty includes in his plan a motor speedway at a much lower level, under the airway—a plan that is directly in line with that proposed by Richard Enright, New York police commissioner, in the hope of relieving the terrific congestion of automobile traffic in America's greatest city.

Three of the World's Greatest Suspension Bridges



These diagrams show the construction of: Top: Brooklyn Bridge, connecting Manhattan and Brooklyn. Center: Philadelphia Bridge to connect Philadelphia and Camden. Bottom: Detroit Bridge to link Detroit and Canada



"The trouble with most of our large cities is that they have failed to look ahead," says Commissioner Enright. "In 1920 we had 50 per cent more automobiles than in 1916. The estimated increase in automobile traffic this year is between 30 and 33 per cent. In 1919, for instance, 39,210 automobiles passed through Columbus Circle, New York City, within a 12-hour period. Today that number has grown to about 70,000.

"We are doubling the number of automobiles, by conservative estimate, every three years. And, with Henry Ford cutting the price of his automobiles and men like W. C. Durant predicting the day of still cheaper automobiles, it is likely the increase will go on at an even greater rate.

"Traffic congestion affects every one in America, not only in discomforts and difficulties he encounters in his own city, but in increased cost of living. Congestion at the waterfront in New York adds to the price of every article that passes through the channel of that waterfront."

Commissioner Enright's Proposal

Enright has proposed long viaducts, stretching half the length of Manhattan Island on both sides, with ramps leading to side streets at long intervals, to take care of auto traffic and relieve congestion. But even he admits that this does not take care of increasing pedestrian traffic nor provide for adequate rapid transit.

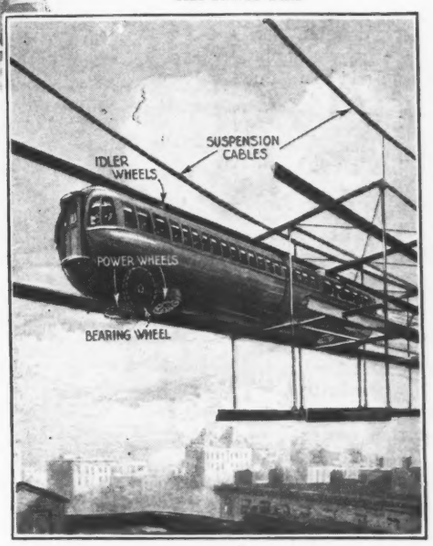
Lafferty's plan makes possible the installation not only of Enright's proposed viaducts, but also of airways for rapid transit. He would eliminate the present unsightly elevated structures of New York, Chicago, Boston, and Philadelphia.

As supports for his proposed airway, Lafferty proposes to use strong steel braced pylons, or abutments, set into bed rock at distant intervals. Strong suspension cables swung between these pylons would support the roadbed. He provides for four tracks, two on an upper deck, on which would run long cylindrical steel cars. He would eliminate excessive wear and tear on cars by having them run on monorails, one rail above the car and the other below it. The car would be supported on the lower monorail by a large bearing wheel at each end, and would be driven by small horizontal power wheels forced by compressed air to grip the track from each side. The car would be held upright by means of idler wheels running on the upper tracks.

Since it would be unnecessary to depend on weight for traction, Lafferty's proposed car would weigh only 20,000 pounds, as compared with the 88,000-pound subway car of the same capacity, now in use.

Entrance to the airways would be by elevators running through buildings situated at street corners, where pylons supporting the suspension bridges would be placed. This feature, of course, would eliminate the present ugly stairways to elevated roads as well as the kiosks for subways.

Below is shown the proposed method by which long, cylindrical cars would run on monorails of an aerial railway. Traveling on single wheels, the car would be propelled by smaller power wheels gripping the lower rail



Close of Greatest Iron Bridge Era Is Near

By Gustav Lindenthal, Designer of the Hudson River Bridge

WITH this century will pass the age of iron suspension bridges. We are about to reach the furthest advance in the art of bridge building we shall ever know. Indeed, the Hudson River Bridge project, most stupendous structure ever proposed, may mark the ultimate in bridges.

Although the twentieth century will go down in history as the great era of steel bridge building, there is little doubt that the year 2000 will see the end of these projects. By that time iron will have become too costly, because of the diminishing supply of iron ore.

We can look back to the time when a suit of armor was almost worth its weight in gold or silver. We cannot see far enough ahead to predict that iron will again become such a costly product, but we do know that it will cost too much to be used in great quantities for bridge building.

Only a century ago the age of iron bridges began. From the early simple bridges of iron were developed the greatest structures of the present—the Brooklyn and Williamsburg suspension bridges, the Firth of Forth cantilever bridge, and the Hellgate bridge, the greatest railroad arch structure the world has ever known. Railroads today are building the finest bridges.

Within the past 10 years the price of steel has almost doubled. The available supply of iron in the world is slowly but surely decreasing.

There may be improvements in the uses of newer materials for some parts of bridges, but in the main it is safe to assert that we are about to say the last word in iron bridge building.

The projected suspension bridge across the Hudson River with central span nearly three quarters of a mile long. Its designer, Gustav Lindenthal (at right), says it may represent the highest possible limit the world will ever see in iron suspension bridge construction

© Paul Thompson

Stepladder Folds into Small Space

A NEW collapsible, rigid stepladder is a valuable addition to household accessories.

The ladder has a skeleton frame of wood fastened together with nickel - plated steel catches. Each step is of two pieces hinged in the center and, when in use, is supported at the center by steel braces. The top step is protected by guards. The ladder folds into 2¾ by 7½ by 52 inches.

This rigid stepladder, when folded, can be hung on the back of a door, as shown below

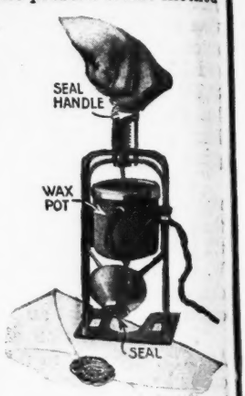
British Learn French by Radio from Paris

MANY persons in London and vicinity are learning to speak and understand the French language as the result of the broadcasting of music and speeches from the Eiffel Tower in Paris. Thousands of British citizens listen in.

Most of the London department stores are selling a cheap standard receiving set from which good results are obtained. Hearing the spoken French over the radio and supplementing this with textbook study, makes it much easier for students to understand and speak the language.

Electrical Sealing Device Eliminates Fire Hazard

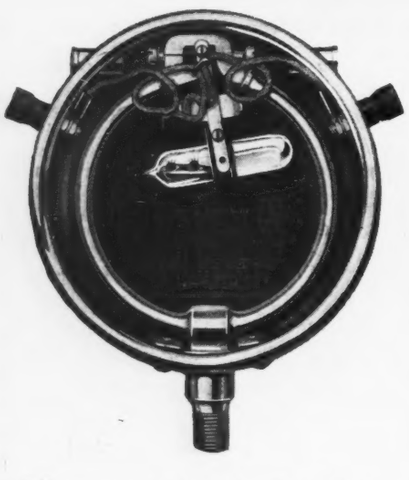
THE recent invention of an electric sealing machine marks the first important improvement in methods of applying sealing wax since King Solomon's time. The new appliance eliminates the fire hazard that accompanies the present crude method of heating the wax over a flame, as well as effecting an appreciable saving of time, wax, and postage.



Electrical sealer, showing wax heating pot

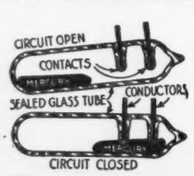
The wax is placed in a container, where it is melted by means of an electric heater. Placing the machine over the spot where the seal is to be, and pressing a small lever releases a small amount of sealing wax. Pressure on the seal handle brings the seal down on the melted wax, completing the operation.

The New York concern that manufactures it claims that the new sealing machine effects a saving of 50 per cent in wax, 50 per cent in time and 20 per cent in postage. The additional expense of the electricity consumed is comparatively small—one half a cent an hour for continuous operation.



Mercury Circuit Breaker Controls Pressures

A GLOBULE of mercury inside a glass bulb filled with an inert gas is being used to control pressures by making and breaking electric circuits. The tube is usually attached to one arm of a Bourbon tube. When the pressure increases, the tube tends to straighten out and the action shifts the mercury from one side of the control tube to the other.



How mercury opens and closes circuit

One or more electrical contacts located within the tube dip into the mercury when the liquid is in certain positions. As the mercury slides back and forth in agreement with the movement of the Bourbon tube, the electric circuits are made and broken.

The tubes have been made for pressure differences of .2 of an ounce, and will handle electric currents of 10 amperes at 110 volts.

Because of the inert gas that instantly kills any tendency of the mercury to arc, the little tubes are said to have a long life.

Writing on "Everlasting" Pad Disappears

AN "EVERLASTING" tablet for memoranda, recently invented, consists of a rectangular sheet of metal, with edges bent over to form a frame, and coated on the upper side with a black composition of waxlike consistency. Over the black coating is a sheet of very tough tracing paper, held in place by a metal strap across the top.

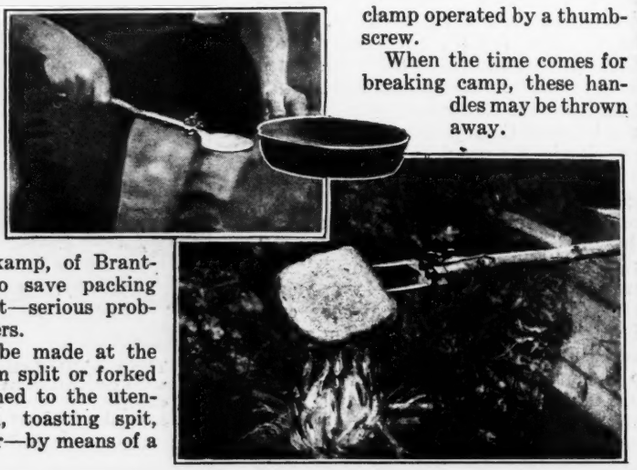
Memoranda are written on the tracing paper with glass pointed stylus. As long as the thin paper remains pressed against the black coating the letters formed by the impressions of the stylus are visible; but when the paper is lifted away, the writing permanently disappears.

Handleless Camping Utensils Save Space

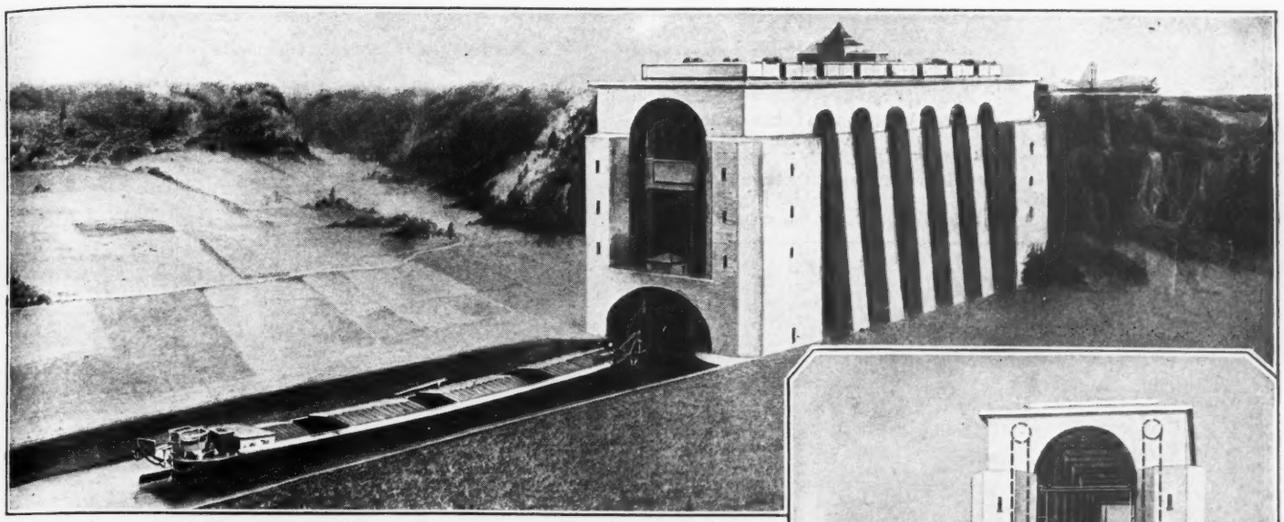
HANDLELESS camping utensils, which can be attached with a thumb-clamp to improvised handles, have been invented recently by a Canadian—William J. Feldkamp, of Brantford, Ontario, to save packing space and weight—serious problems for all campers.

Handles may be made at the camping site from split or forked sticks and attached to the utensils—fork, spoon, toasting spit, or pancake turner—by means of a clamp operated by a thumbscrew.

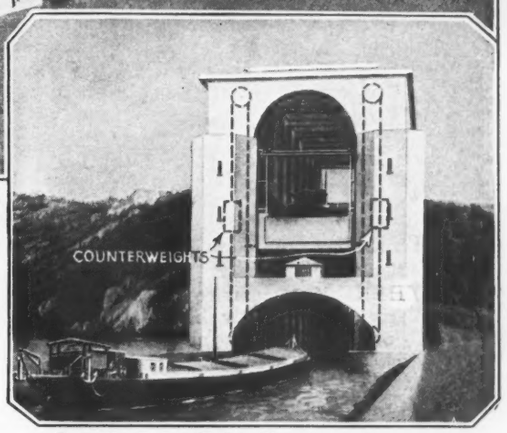
When the time comes for breaking camp, these handles may be thrown away.



Elevator Locks to Lift Barges over Dry Plateau

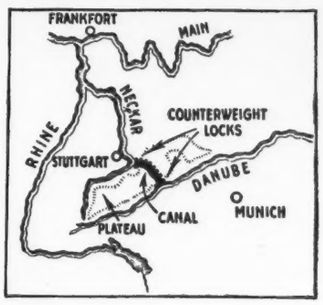


To carry boats through the proposed canal between the Rhine and Danube (see map), 26 massive counterweight lift locks like that shown above would be required

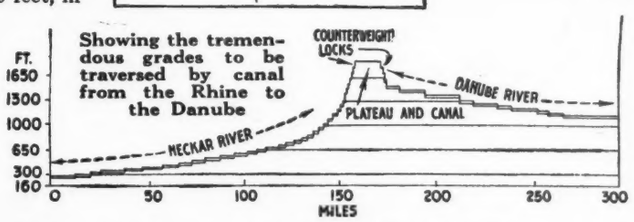


Entering the lock, the boat floats in a water-filled trough suspended on cables that pass over drums at the top of the lock. The elevator trough is lifted by counterweights and electric motors

DESPITE unsettled industrial conditions, engineers in Central Europe are planning the construction of what will be one of the world's most important artificial waterways—a water route from the North Sea to the Black Sea, extending 2100 miles across the European continent, and linking the Rhine and Danube rivers in Germany. Tremendous engineering problems are involved, for such a canal would have to traverse the Alb plateau lying between the upper Danube and the Rhine, at a height of 1830 feet, in a region where water is scarce.



The scheme involves the canalizing of the Neckar River, a tributary of the Rhine, up to Plochingen, Würtemberg — a point 35 miles distant from Ulm on the Danube—and an extension of navigation up the Danube to Ulm. Between these two points the canal would have to be carried over high plateaus by systems of locks.



The absence of an adequate water supply for the operation of locks involves the most serious problem, which engineers propose to solve by using immense mechanical lifts.

Twenty-nine of these lifts will be required since the plateau rises nearly 1500 feet above the Rhine end of the waterway at Mannheim and 300 feet above the Danube end at Ulm. The proposed counterweighted lift lock is a massive structure of concrete and steel, capable of lifting 1200-ton boats 86 feet. The elevator consists of a trough filled with water in which the boat floats. This trough is suspended from the structure by wire cables that pass over drums at the top and are attached to counterweights. Electric motors, operating endless link chains, supply the power.

To elevate a ship the trough is brought to the lower level; then a safety mechanism opens the lower gate. The boat is drawn into the lock by means of a cable operated from within the lock and when in position the lower gate is closed, imprisoning the boat and sufficient amount of water to float it.

Power is then transmitted to the endless chain for the lifting. The counterweights are sufficient to balance the trough and its load so that just enough power is required to overcome friction in the operating parts.

When the trough has reached the upper level, the safety mechanism again allows the upper gate to be opened and the boat is free to continue its journey. Thus the water is conserved in the upper reaches and there is no danger of the canal running dry.

It is estimated that 50 ships could pass through the canal daily. This canal would be as important as the Suez and Panama canals, for it would provide a short and cheap route from the North Sea to the Mediterranean and the East.

Fortune for Inventor Who Saves Mountains of Grape Pulp

FORTUNE awaits the man who discovers a profitable method of converting into salable jellies, cream of tartar, oils, and extracts the enormous quantities of grape skins and pulp wasted each year by grape juice factories.

Reports of the Department of Agriculture show that the average quantity of grapes crushed yearly for beverage purposes in the five years ending in 1918 was 22,000 tons. Of this amount 660 tons was discarded as stems and 4400 tons as wet pulp.

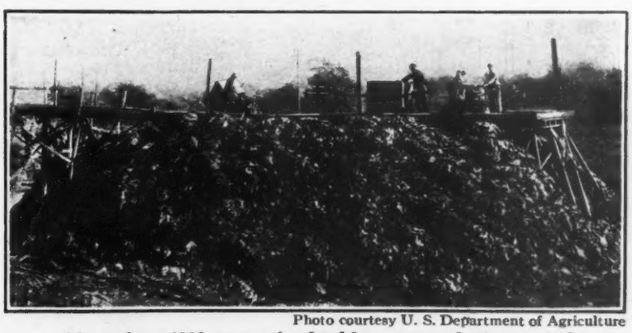


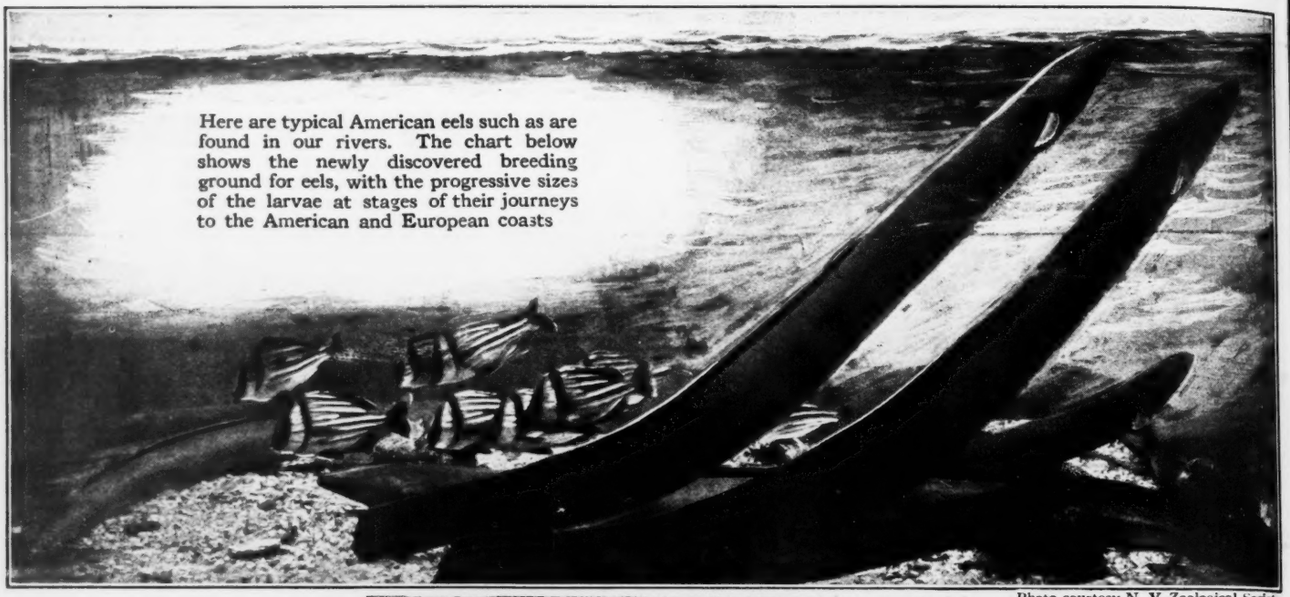
Photo courtesy U. S. Department of Agriculture

More than 4000 tons of valuable grape pulp is wasted each year at grape juice factories in piles like this

From the stems it would have been possible to obtain 13.2 tons of cream of tartar. The seeds in the pulp would have yielded 89.3 tons of oil and 526.7 tons of oilcake. Even the hulls would have added their share in the form of nearly 50 tons of tannin extract.

Experts estimate that 3300 tons of wet grape skins goes to waste annually.

Mysterious Birthplace of Eels at Last Discovered



Here are typical American eels such as are found in our rivers. The chart below shows the newly discovered breeding ground for eels, with the progressive sizes of the larvae at stages of their journeys to the American and European coasts

Photo courtesy N. Y. Zoological Society

"WHERE do eels come from?" This apparently simple question has for many years excited the curiosity of scientists. Strange to say, the eels familiar to us in aquariums and museums have been a complete mystery to naturalists. Nobody had been able to find baby eels. Nobody knew where they were born. The grown eels appeared mysteriously along the coasts of Europe and America, and disappeared just as queerly. Where did they come from?

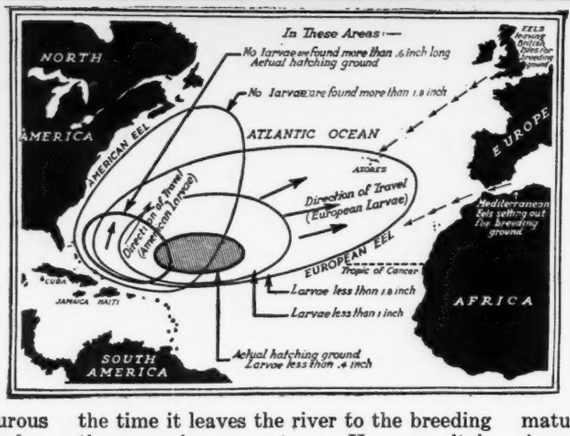
Now, a Danish zoologist, Dr. Johannes Schmidt, after years of research, has returned from an adventurous ocean voyage with the report that he has discovered a breeding place near the Bermuda Islands, in the Atlantic Ocean, from which all the eels that inhabit the waters of our rivers have migrated.

In 1904 a small transparent leaflike fish about two inches long was captured off the north coast of Scotland. Doctor Schmidt concluded that this was the larva of the common eel found in European waters. He set out in a small ship and fished all over the Atlantic Ocean, charting as he went, following trails which led him to the capture of smaller and smaller larvae, until he finally reached their breeding grounds.

How the Eel Develops

The history of the eel, as discovered by Doctor Schmidt, shows that the larvae during their first year gradually move away from the breeding zone, and by their third summer are off the coastal banks of Europe, in the case of the European eels, where they are about two inches in length. Then a strange change takes place, for the larva shrinks in width and length, becoming round instead of flat. It is then known as an elver, and begins to ascend rivers into fresh water, where it lives and feeds for from six to 20 years.

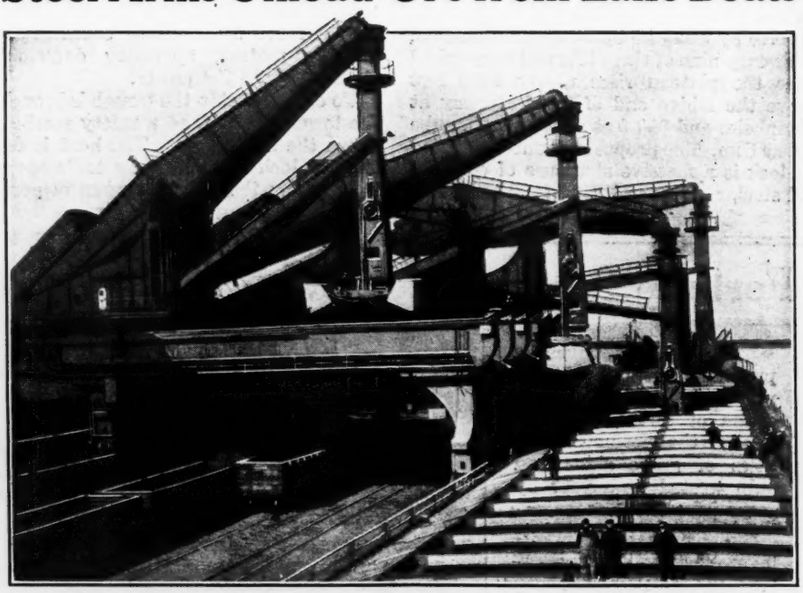
At some time during this period the reproductive organs suddenly develop, the eyes become larger and the female assumes a silvery bridal coat. Then the eel starts its journey back to the spawning grounds. What happens to the eel from the time it leaves the river to the breeding time remains a mystery. However, it is known that the fish never returns after laying her eggs.



A difficult problem confronted Doctor Schmidt when two species of eels, the European and American, differing radically when full grown, were found together at the spawning grounds. How did the newly born eels know whether to start for Europe or America?

Since the journey to Europe takes a year longer than to America, Doctor Schmidt concluded that those European larvae which started for America, arrived there too soon, before they had grown sufficiently to reach the stage where they could live in fresh water. Therefore they perished before maturity. Similarly, he believes, no American eels are found in European waters because they require fresh water long before they can get it.

Steel Arms Unload Ore from Lake Boats



TWO carloads a minute is the rate at which these huge mechanical arms transfer ore from lake boats to freight cars at Ashtabula, Ohio.

Buckets are suspended from long steel plungers, the upper ends of which are pivoted to walking beams supported by movable trucks on rails

Science to Salvage Fuel from Mine Waste Piles

THE critical fuel shortage in the United States, due to diminishing available coal and to unfavorable industrial conditions, is commanding the attention of scientists and inventors, who are experimenting with methods of salvaging vast piles of "coal waste" containing enormous quantities of fuel.

The waste at the mines consists largely of slack—fine screenings of coal dust and dirt-culm, an inferior slatelike anthracite, and gangue, or mineral matter found in coal veins. Improvements in heating apparatus that permit industries to burn much finer coal than heretofore have aroused inventors to attack waste piles which, until recently, have been considered as not worth the cost and trouble of salvage.

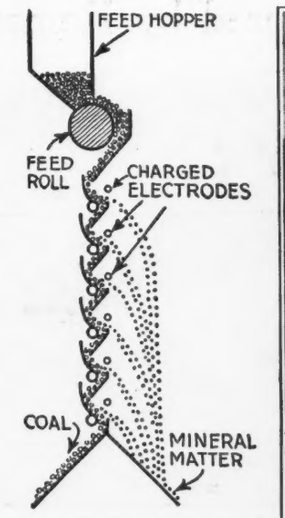
Minerals Separated from Coal

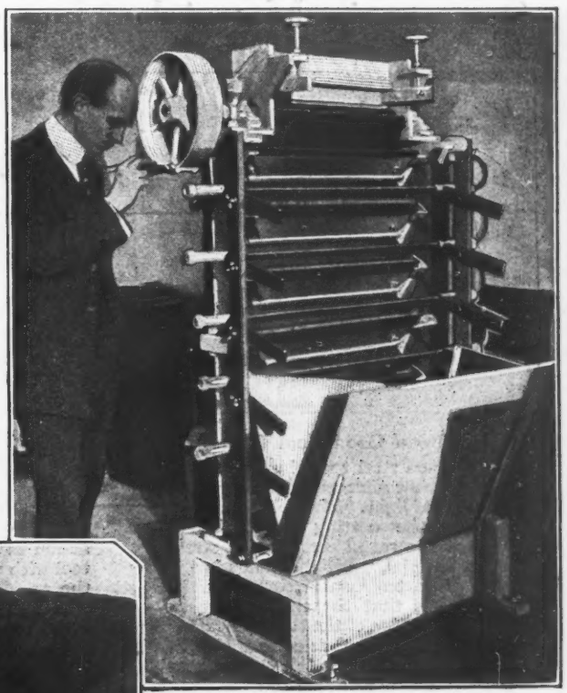
One ingenious new salvaging machine works on the principle that gangue, particularly that containing iron, may be separated from the coal if brought into contact with a magnetized or electrostatic field.

The process consists first of crushing the coal waste and then sifting out coal particles of such fineness that they would be likely to form an explosive dust. An explosive-preventing gas is used also to treat the coal, to insure safety and also to remove some of the moisture that might retard separation. The crushed coal and gangue are then dumped into the apparatus for separation.

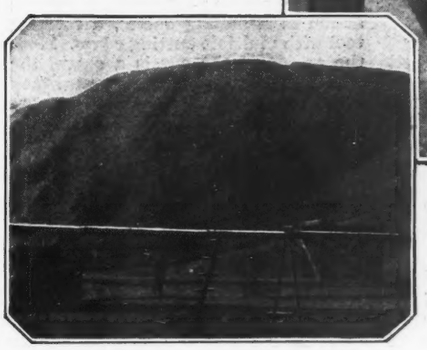
From a feed hopper, the mixture drops to a feed roll that tends to keep the flow slow but constant, then to the first of a series of electrostatic fields, where some of the iron-containing gangue is charged by electrodes. In passing from one electrostatic field to another, the mineral matter, as it becomes charged, is repelled by the charged electrodes and thrown to one side. Meanwhile, the non-conductive coal passes undisturbed from one field to another, finally falling into a container at the side of the machine opposite the minerals.

Thus, in one operation, most of the gangue particles are separated by repulsion from the coal particles. Repeating the operation makes the separation more complete. An alternating current with a voltage of 15,000 to 25,000 has been found to give satisfactory results in charging the electrodes.





As coal mine waste passes through a series of electrostatic fields in this salvaging machine, mineral matter is sorted from coal by charged electrodes, as shown in diagram



The "coal mountain" shown at left is typical of the piles of waste containing vast stores of fuel waiting to be salvaged at our coal mines

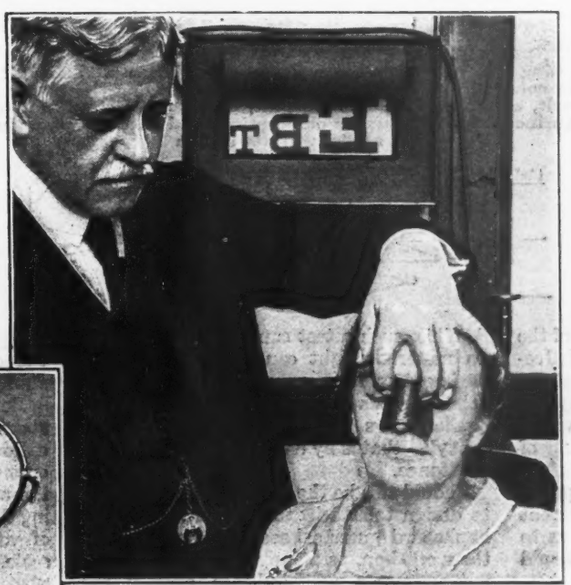
Eyeglasses Fitted on Plaster Casts of Patients' Noses

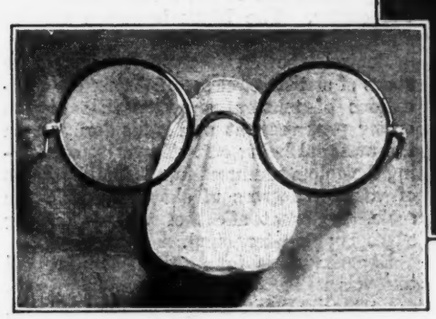
BY MAKING plaster casts of the noses of patients who come to him for eyeglasses and spectacles, Dr. Nelson Y. Hull, of New York City, is able to provide glasses that fit perfectly, even if the patient does not appear in person at his office after the first visit, when the cast is made.

Since no two noses are alike, the nosepiece of glasses for each individual patient must be delicately curved and adjusted. Some noses are very hard to fit because of unusual contour, and for this reason patients have sometimes been subjected to tedious fittings.

By using plaster casts, Doctor Hill not only obviates this inconvenience, but keeps permanent records of the nose bridges of all his patients for future reference—which is found very useful, particularly when filling emergency orders for new pairs of glasses.

Markings are made on the plaster cast to indicate exactly where the nosepiece of the glasses should rest. In many cases, Doctor Hull has found it easier to make accurate adjustments on the cast than on the patient's nose.





On a plaster cast exactly duplicating the contours of a patient's nose, spectacles are fitted as shown at the left

Cows Thrive on Sawdust

DAIRY cows give just as much milk when a third of their food consists of hydrolyzed sawdust—that is, sawdust resolved into other compounds by taking up water.

The Wisconsin Agricultural Experiment station reports as follows:

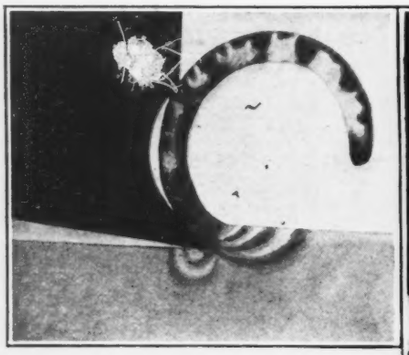
"Two groups of three cows each were fed for 70 days. One group received a ration of alfalfa, hay, corn silage, and a concentrated mixture of 60 parts yellow corn and 20 parts linseed meal. The ration for the other three was the same except that hydrolyzed sawdust, made from Western white pine, was gradually substituted for ground corn at the rate of two pounds of sawdust for one pound of corn.

"When the percentage of sawdust reached 40 per cent, two cows failed to eat the mixture well; but when the proportion of sawdust was reduced to one third, no difficulty was experienced."

Rainbow Colors Betray Cutting Faults in Tools

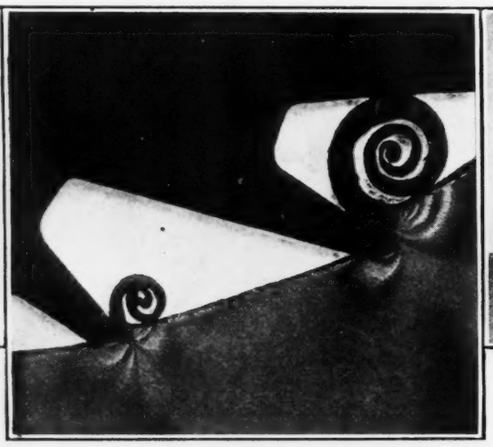
Stresses in Materials Measured by Remarkable New Apparatus

Photos © Popular Science Publishing Co., Inc.



How a Good Tool Cuts

A sharpened steel tool planing a plate of translucent nitrocellulose in a polarized field of light. The color bands in front of the cutting edge indicate variations in radial compression stress in the material, while the bands in the rear measure tensional stress behind the tool. Note that the shaving breaks away at the edge of the tool, indicating true shearing action, as compared with wedgelike action of a dull tool, shown in the third picture



This remarkable photograph shows the action of a milling cutter, a rotating tool with multiple cutting edges. Since the profile of the cut is a curve, the shaving increases in thickness. Black stress patches in the shaving indicate that it is not sheared off as it should be, but is being wedged and torn off by jerky action of the cutter

How a Poor Tool Cuts

An improperly shaped planing tool in action. The tool acts as a wedge forced between the shaving and body of material, tearing away the shaving by jerks and producing a rough surface on the material. Note that the imperfect tool has pared off a second threadlike shaving by a double cutting action. Because of the tearing action of the tool the shavings split away in advance of the cutting edge

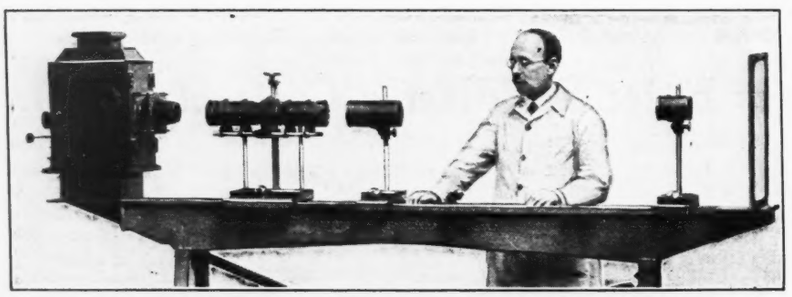
WHEN you cut a piece of steel or other metal with a dull tool, just what happens in the metal?

Every mechanic recognizes the necessity of having keen edges on his cutting tools; yet the exact effect of dull tools on the material—in terms of strain and stress, in splitting and in jagged surfaces—has remained a mystery.

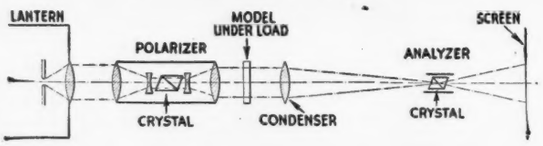
To obtain scientific knowledge of these facts—of tremendous value in every modern workshop — engineering experts of University College, London, recently discovered a remarkable way of studying the cutting action of tools by means of rainbow coloring of translucent material under stress, when subjected to polarized light. By this method they have obtained colored photographs, reproduced in black and white on this page, of such materials as they appeared during the cutting process.

The polarized light used in these experiments was obtained by passing sunlight through a crystal of Iceland spar. A light ray is caused by a vibration in the ether, which moves back and forth across a straight line that marks the direction of the ray. When this ray is passed through Iceland spar, only those vibrations that strike the crystalline structure longitudinally are permitted to pass, while the other vibrations are arrested. The peculiar property of the emerging ray is that all its vibrations are in a single plane. It is known as polarized light. The light affects transparent materials under stress in such a way as to produce colors that ordinary light would not reveal.

It has long been known that vivid colors are produced when polarized light is passed through a substance under stress. This is due to the fact that material under tension elongates, and becomes distorted. Similarly, compression thickens the material with corresponding distortion. Thus, a definite pull on a translucent body may be expected to cause a definite distortion, and if light rays are passed through it, the shade and degree of coloring should be in proportion to the amount of stress.



Translating varying degrees of stress in material under load in terms of rainbow colors, this ingenious apparatus for studying the action of cutting tools, explained in diagram below, projects polarized light through the translucent material under observation, and onto a screen. In photo, model was not shown



While such a test can be conducted only on materials light can penetrate, the experimenters have assumed that steel and other metals that must be cut follow similar laws and can be studied "by proxy"—that is by analysis of a translucent substance.

Should this be the case, it will be possible to design tools scientifically, instead of by haphazard guesses based on experience in the workshop, as at present. Photo-elastic measurements will indicate exactly the proper depth of cut that should be made when turning or planing a particular material and will undoubtedly result in enormous saving of power now wasted by ineffective tools. Engineers will be greatly assisted in attaining "the one best way of workmanship."

In the polarized light experiments, nitrocellulose, a transparent substance, is used. While the material is being cut on a lathe, milling machine or planer, polarized light is passed through it in the vicinity of the cutting edge. When this light is projected on a screen while the cutting operation is in progress, it is noticed that rings of color precede and follow the tool as it plows its way along the material. These rings are of varying shade and intensity and seem to circle about the tip of the tool.

Further tests on stationary materials under known loads have resulted in the compilation of a color scale by which the colors can be interpreted in pounds of stress. Thus, in a cutting action, a series of concentric circles of color precede the tool, advancing like a rainbow through the material and ranging from black at the tip of the tool to reds that become paler at a distance from the cutter. This indicates that the material is under compression due to the forward motion of the cutter. The black indicates stresses sufficient to break apart the substance.

Behind the cutting point is another series of similar circles; but these are indications of tension, showing that as the cutter progresses it still pulls forward on the material being cut. Thus, by comparing the colors produced in material by edges of varying degrees of sharpness with the scale, the exact effect of various cutting edges can be determined.

Experimenters found that when a dull tool was used, the stresses were enormous, as shown by black fringes about the tool.

New Low Voltage Tube Makes Radio Sets Simpler

Expert Reports Remarkable Success with Simplified Receiving Outfit

By Armstrong Perry

LONGER life for the vacuum tube, greater economy, a more simple and convenient receiving set, and one that may easily be carried about from room to room or to a friend's house—these things are made possible by the use of the new low-voltage electron tubes that require only a dry cell to light the filament.

Despite the whirlwind spread of radio in the past year and a half, there are still literally hundreds of thousands of people who would like to enjoy the advantages and pleasure of having a receiving set in the home, and somehow haven't got around to installing one.

The fact that the electron tube set has required a storage battery for the tube filaments has unquestionably deterred many of these possible purchasers. Not only has the storage battery seemed to them likely to be cumbersome and hard to place in a room, but in addition they have hesitated because of the nuisance of having the battery frequently recharged, and the fear that its acids might ruin rugs.

Portable Outfit for Beginners

Today these radio beginners may start with a single circuit set and the new low-voltage tube lighted by a dry cell battery of the kind used to ring the doorbell. Of course, when the storage battery can be permanently installed, and can be recharged without disconnecting or moving, it remains the stand-by of the full-fledged radio fan. It is essential to loudspeaking results with power amplifiers, and sooner or later every radio user gets to the point when he wants to own a two-stage radio set with a loudspeaker, so that all the family and guests may enjoy the evening's entertainment. So it will be seen that the storage battery is still to be reckoned with. But the fact remains that for the beginner who wants a simple and portable outfit, the new dry cell tubes have saved the day.

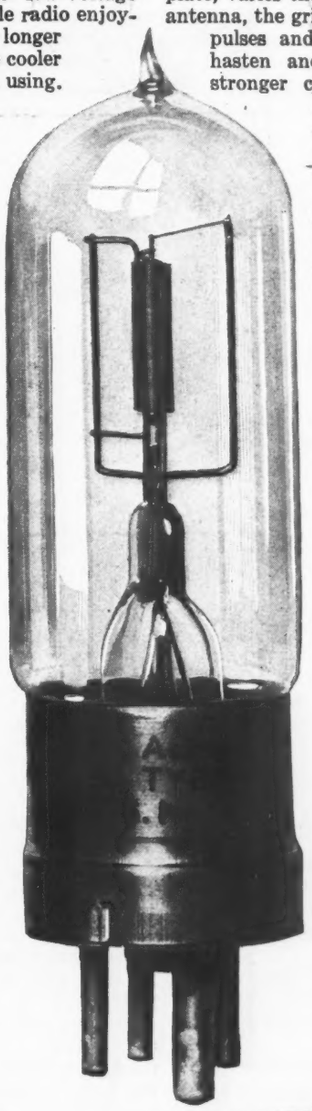
When a well-known concern advertised a receiver using tubes that would operate with only a dry cell to light the filament, and the usual compact and light B battery, I was skeptical but hopeful. I lost no time in trying out one of them. That was a year ago. For some time the low voltage tube could not be purchased except in connection with a complete set. Now it is available to any one who has the price, and it can be applied to any style of tube outfit.

The development in these low-voltage tubes means not only portable radio enjoyment, but it means tubes of longer life; simply because they are cooler than the tubes we have been using. Some progress has been reported in designing a tube that will operate with a cold filament, but to date the incandescent wire seems to be necessary for practical purposes. There must be a flow of current through the tube without contact between its internal metal parts, because it is by altering the flow of this current that we get sounds louder than can be produced by using only the current the antenna brings in.

A crystal detector set, using only the energy brought in from the distant transmitting station, is limited in its range. The electron tube set, using the energy from the distant station as a trigger to release many times more energy from a local source, is much more efficient.

Electron Tube Principle

In order to produce a flow of current through the electron tube, it seems necessary at present to heat the filament because it will not throw off electrons otherwise. Electrons are the minute divisions of matter that when flowing, make up the electrical current. The filament, when heated, throws them off; the plate, positively charged, pulls them in, and the grid, standing between the filament and plate, varies the flow. Connected with the antenna, the grid receives the incoming impulses and uses them to alternately hasten and retard the flow of the stronger current and thus make it ripple like the waves that radiate from the transmitter. These ripples are changed by the action of the phones into sound waves exactly similar to those produced by the speaker, singer, or musical instrument at the broadcasting station.



In the ordinary types of tubes that we have been lighting with our storage batteries the filaments glow brightly. To heat them to incandescence a comparatively large amount of current is needed. Metals deteriorate rapidly when heated. When overheated, as the filament is when we accidentally make a wrong connection and shoot 22½ volts from the B battery through it, it may burn off in a few seconds. At best the filament is shorter lived than we wish it were.

Tube Glows Dimly

The low-voltage filament is long lived because it glows dimly. I took a set using the dry cell tube up to a roof one day, hastily improvised an aerial, and turned on the juice to hear a speech in a town 50 miles away.

A two-pound dry cell does the work of a 40-pound storage battery

The new low-voltage vacuum tube shown above is a marvel of fine and compact workmanship. The delicate grid and filament, correctly spaced and carefully adjusted, are contained inside a small hollow cylinder that acts as the tube plate

Compare the size of the bulky storage battery in relation to the ordinary high voltage tube (at left) with that of the compact dry cell in relation to the new low voltage tube (at right)

The filament appeared to be as coldly passive with the juice on as it did with it off. I turned the rheostat knob as far as I dared. No result.

Hoping against hope, I put on the phones. Instantly I began to hear the speech. The trouble was with me, not with the tube. I had forgotten the maker's admonition that the filament shines so dimly that in bright sunlight the glow of it may not be seen.

Not so long ago I visited a fellow who had

recently been bitten by the radio bug and had purchased a set with a dry-cell tube. It was all right as far as it went—brought in stations over a radius of two or three hundred miles—but he wanted a heavier volume of sound, so he bought a two-stage amplifier and a storage battery to light its filaments. I listened in with and without the amplifier, and so far as I could judge, the low-voltage tube delivered just as good average results as any other I had tested, both when the detector was functioning without amplifiers and when its output was fed to the amplifiers. I heard Chicago, Detroit, Louisville, Schenectady, and other broadcasting stations without difficulty and I was then in eastern Pennsylvania.

Many Users Satisfied

Recently in Washington it was noised around the government offices that the navy was selling crystal detector sets of very efficient design at a low price and that they could be converted into tube sets without difficulty. Two or three thousand sets were sold to government employees and other citizens, I am informed, and one reliable dealer told me that he sold as many as 50 low voltage tubes in a day for use with these receivers. He said that no complaints had been received and that the users were evidently satisfied with their performance.

Radio experts and dealers are not unanimous, however, on the question of tubes. I asked a salesman who is an expert if he would help me assemble a good low-voltage tube set for a friend.

"Yes," he said; "but you're crazy to get one. They are not nearly as efficient as the sets that use standard tubes and storage batteries."

This man, whose word I have learned to rely on, was giving me the best advice he could from his point of view. The difference in the evidence emphasizes the fact that different men have unaccountably different experiences with the same kinds of apparatus. It is hard to find two experts who agree on any proposition where tubes are concerned.

Tubes Withstand Rough Usage

At my club I saw an expert install a glorified set using six low-voltage tubes. One thing about it that impressed me was the ruggedness of the tubes, which looked exceedingly delicate, but stood up under very rough usage.

Radio experts, when testing out a set, change about the tubes a good deal, and this man was no exception. He tried every tube in every socket times without number. In his hurry—his audience was due in 15 minutes—the tubes rolled all over the place and fell off of boxes and were subjected to varying voltages, yet they all came through alive. Not one broke or burned out during the time they were under my observation.

This ability of low voltage tubes to stand punishment is phenomenal in view of the delicacy of the filament, which is eight times thinner than tissue paper and only a hundredth of an inch wide. In welding the filament to end supports and attaching these to the springs that absorb shocks, the tube makers perform an operation that for delicacy has anything the watchmaker does "skun a mile."

Above is a complete low-voltage tube set, recently marketed, using an ordinary dry cell to light the filament. At right is the adapter that makes it possible to use the low voltage tube in any tube set without changing sockets or wiring. In using the adapter, care must be taken that the storage battery is disconnected from the circuit before the dry cell tube is inserted. Otherwise the tube may burn out

The low voltage tube has four prongs, like its larger cousins, but one of the prongs is fatter than the rest, so that it is impossible to put any of the prongs into the wrong holes and thereby connect the filament with a voltage intended for the plate only.

Soon after the new tube was made available to the public, some genius put on the market an adapter that made it possible to use the low voltage tube in sockets designed for the older types of tubes. Now any one who owns a tube set can try out the low voltage tubes without change of wiring.

Any one who has tried to light the old style tubes with dry batteries and has discovered that the batteries run down in a few minutes, naturally asks how long a dry cell will operate the new tubes. The new tubes, while using 1.1 volts as compared with the four to six volts required by the old, pull only 0.2 amperes as compared with 0.75 to one ampere required by the higher voltage tubes. The power consumption of the old type tube is three to five watts in the filament; in the new type it is only 0.25 watts. So an ordinary No. 6 dry cell may last 90 hours or more, provided it is not used more than one hour in 24. The life of a dry cell is shortened by drawing on it for long periods.

The ordinary types of B batteries are used with the low voltage filament tubes. The plate takes the ordinary voltage—22½. An increase to 30 volts may improve the results slightly.

The first of the low voltage tubes was not adapted for use as an amplifier, but the manufacturers have now produced an amplifier tube that also can be lighted by dry batteries. It can be used for increasing the power of a crystal detector set.

Radio on the Road

This victory of the dry cell tube in making possible a light, compact receiving set of long range, marks an important epoch in the extension of radio usefulness.

Now we can take our radio set with us wherever we go, receiving the best that the air has to offer. We can pack our receiving set in the bag with our collars and toothbrush. On our hunting or fishing trips, or on our auto camping expeditions we can tote it along with little trouble.

With a portable tube receiver and an antenna plug for connecting with lighting circuits, the traveler can keep in touch with the world from his hotel room. Or, by stringing a short length of wire or using a coil aerial on his automobile, he can make it a traveling radio station without carrying bulky apparatus.

More important still—the dry cell tube receiver will carry the joys of radio to thousands of persons to whom it is still an unknown mystery. Contrary to the general impression among radio men that almost every one was initiated to radio last winter, I discovered during a recent trip through small towns and country districts in six states that more than 90 per cent of the folks I met had never heard anything about radio. Most of them never had seen a radio set.

Thousands to Learn of Wireless

To these thousands, salesmen with portable sets now can carry radio. In demonstrating their goods they will find an enthusiastic welcome.

Finally, think of what the portable receiving set will mean in carrying cheer to shut-ins, entertainment and education to out-of-the-way places, and up-to-the-minute information to offices and workshops.

No longer is the enjoyment of radio programs confined to those who can afford a storage battery. The introduction of the dry cell tube has halved the cost of a vacuum tube outfit.

To make a long story short, radio has caught up with the cartoons which, in the hectic winter of 1921-22 pictured for us the manifold possibilities of this marvelous agency for carrying the human voice to listeners hundreds of miles away.

A Low Voltage Tube Set for $20

OUR radio editor has just completed a remarkably simple and easily tuned low-voltage tube set at a total cost, including phones and aerial, of about $20. Every reader will be interested in the construction of this outfit. It is to be fully described in the April issue.

Hunters with Lasso Capture Polar Bears Alive

COWBOYS of the Western ranches whose business has outgrown their art, except in the movies, have found a new field in the Far North, using their lassoing skill to capture live polar bears. A recent expedition employing about a hundred men skilled with the coiled rope, recently caught about a thousand full grown bears in this way. Some of the bears were killed for their meat and skins, while others were kept alive to be sold to zoos.

The polar bears bask on ice floes. The hunters' boat, a fishing schooner, was maneuvered in and out of the ice floes until a bear was spied. Seeing the boat approaching, the bear invariably took to the water and the hunters found that they could effect a capture only by following him with an auxiliary high-speed power launch.

When the power boat came within casting distance of the bear, a skilled rope artist threw a lasso over the animal's head, manipulating the rope so that the bear struggled to release himself. The result was that the bear worked his head and shoulders through the loop and the rope could then be tightened without danger of strangling the animal.

As soon as the bear was securely roped, the launch towed him longside the ship and he was drawn aboard by means of a derrick. The hunters report that the sport was equal to anything they have ever experienced, for long battles were sometimes necessary before the animal could be hoisted aboard the schooner.

Captured alive, a full grown polar bear is hauled aboard ship after the animal is lassoed, as shown at right. Nearly 1000 bears were caught in this manner during a recent polar hunting expedition

Automobile Body Skeleton Serves as Chassis Frame

A "FRAMELESS" automobile chassis, radically different in principle from the conventional design, was an interesting feature of a recent Paris automobile show. Although the question of just how a car of this general type would perform over rough roads, is a disputed one, experts generally agreed that some of the principles employed may find wide use in the future.

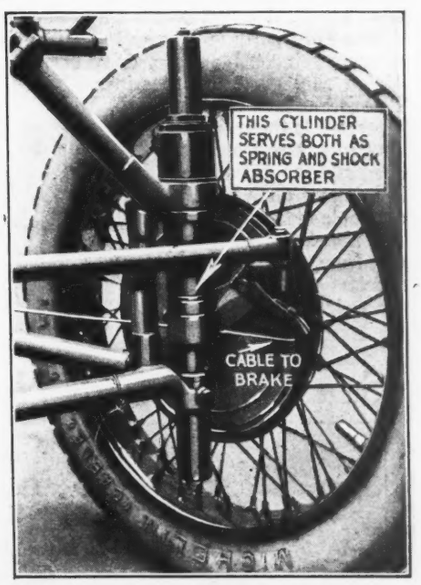
An important advantage of the new frameless car is its extraordinarily light weight and comparatively simple construction. The body of the car is the only structural member connecting the front and rear axles. Metal sheeting cut out with a die performs the double service of carrying the weight of the body and its contents as well as taking the place of the chassis frame.

Metal Frame Can Be Enamelled

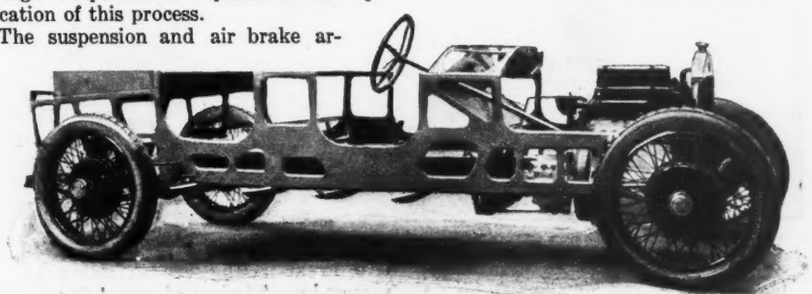
It is this arrangement that gives the car its light weight, while the strength is as great as that of a heavy frame. A secondary advantage is that durable baked enamel finish can be applied throughout, whereas the present wooden frame prevents the use of high temperatures required in the application of this process.

The suspension and air brake arrangements on the front wheels are other unusual features. The front wheel is mounted to slide on a vertical guide pressing against the action of coiled springs and, through a piston, against water pressure in a vertical cylinder situated alongside the wheel. This arrangement eliminates the springs and shock absorbers now in use.

Brakes are provided on all four wheels, those in front being operated by a wire cable attached to a lever, the movement of which governs the brake band. All four brakes are operated simultaneously by pressing on a single foot pedal.



Spring suspension and brake arrangement of front wheel, showing cylinder mounting in which coiled springs and a piston operating against water pressure absorb shocks



Photos courtesy Automotive Industries

A light sheet metal skeleton—the only structural member connecting front and rear axles—takes the place of a chassis frame in the new "frameless car"

A Vacuum Clothes Brush

THEY are saying good-by to the whiskbroom in barber shops in Chicago. Attendants are using a small vacuum type dust collector, weighing no more than the electric flatiron. It is far more hygienic than the whiskbroom germ scatterer.

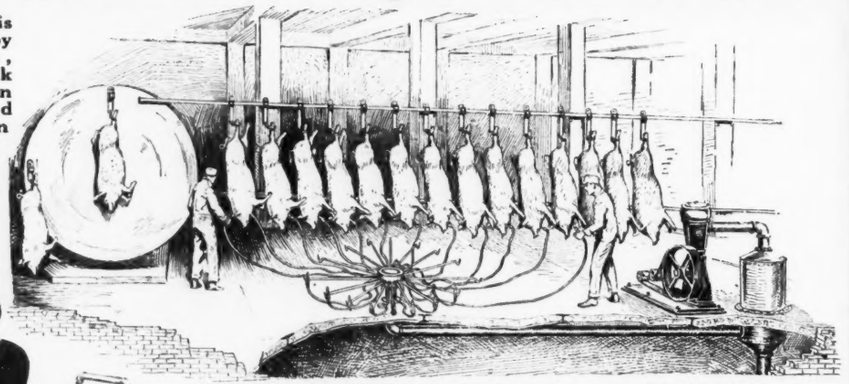
Suction Knife to Revolutionize Slaughterhouse Methods

DESIGNED to eliminate the barbarity of slaughtering methods now in general practice, a new butchering device, manufactured by a concern in Kansas City, Mo., provides a cleaner and quicker method of killing animals.

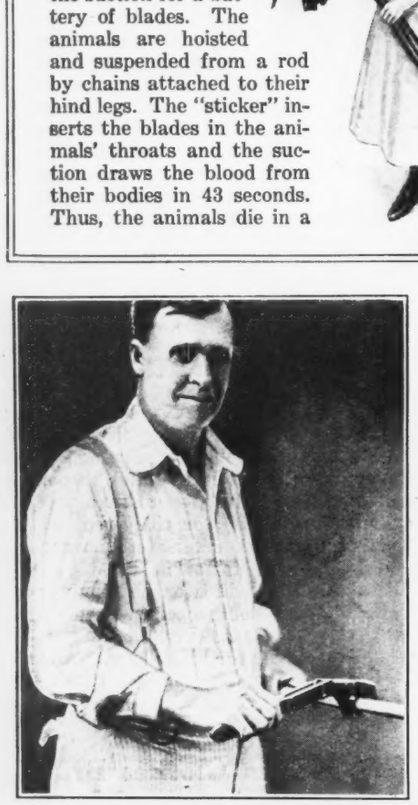
The mechanism consists of a suction pump to which is attached a hose equipped on the end with a sharp blade. As used in slaughterhouses, a centrally located vacuum pipe provides the suction for a battery of blades. The animals are hoisted and suspended from a rod by chains attached to their hind legs. The "sticker" inserts the blades in the animals' throats and the suction draws the blood from their bodies in 43 seconds. Thus, the animals die in a most humane way and their blood is conserved and kept clean throughout the entire operation. In cleanliness, the invention will transform slaughterhouses, where butchers now wade in blood as they work.

Although the present tendency in butchering is to relieve suffering as much as possible, yet killing by the present methods requires from two to five minutes. The saving that may be effected by the new slaughtering implement may be realized when it is considered that the line of cattle, sheep, and swine killed each year in America for food and serums, would extend a distance of 181,000 miles, or about five times the distance around the world.

Blood is saved by clean, quick suction method shown below



In the slaughterhouse, suction for a battery of knife blades inserted in the animals' throats is supplied from a vacuum pipe



Easily Fitting Pipe Wrench Threadless and Nutless

ONE of the recent additions to the pipefitter's toolchest is a threadless and nutless pipe wrench, invented by Walter I. Brockover, of Tipton, Ind., which can be used on pipes of varying sizes without preliminary adjustment.

The wrench consists of three parts: a handle and upper and lower movable jaws. The upper jaw and the handle each have two arms that are pivoted in such a way as to allow room for motion of the lower jaw about its pivot in the handle.

In use, the wrench is hooked over the pipe and the lower jaw is raised to contact with the other side of the pipe. Bending the wrench by pressing down on the handle causes the lower jaw to move forward and the pipe is thus very firmly gripped by the teeth of the jaws.

To release the pipe wrench, it is necessary only to raise the handle. The lower part is drawn back by this motion and the teeth are disengaged.

Three-Wheeled Auto Built of Old Parts

FROM a few spare Ford parts of standard type and connecting parts made at home, J. O. Michaud, of Fort Kent, Me., has built a serviceable three-wheeled automobile.

The Ford parts used were three front wheels, front wheel steering spindle, rear axle, drive shaft, pinion ring gear, and bearings. The chassis frame was of iron pipes, while the reducing coupling, the transmission, and the drive shaft housing were made from available material.

A nine-horsepower engine from an old car gave satisfaction. The entire car weighs 610 pounds.

Three-wheeled auto as assembled from old parts

Sea of Soapsuds Novel Window Display

BY FORCING compressed air through a soap solution in an electric washing machine, a furniture store has adopted a novel window display scheme which has proved effective in attracting the attention of passers-by. The sea of soapsuds produced covers much of the display.

Photo courtesy American Museum of Natural History

This monster South American bat is first cousin to our leather-winged species. Scientists now say bats may be used to police our homes against insects

Until recently the bat was one of the least known American mammals. There are 150 species, some of which have as large a wing spread as five feet

Proposes Pet Bats to Drive Insects from Our Homes

RESEARCH that soon may result in the employment of the ordinary leather-winged bat to police our homes against flies, insects, and mosquitoes, is now being carried on by certain scientists who have undertaken a thorough study of the subject. San Antonio, Texas, and some cities in Florida have already used bats successfully to fight malaria bearing mosquitoes.

These men picture the bat making its home in a dwelling, darting here and there, and killing all invading insects. To prove this is entirely feasible, they introduced two bats into their own homes after being bothered by mosquitoes. The result was that the bats disposed of all of the insects in a single night.

Two difficulties have arisen, however. In the first place, they have not yet found an adequate way to keep the bats alive in captivity. They feed only while on the wing, and unless supplied with large numbers of insects, do not get enough food when kept in a laboratory. Secondly, since the bat is little more than a winged mouse, women feel somewhat timid about having such a policeman around the house.

The real importance of the research lies in the discoveries of the value of bats as destroyers of insects that damage crops on farms and as annihilators of mosquitoes. They are confident their studies will enable them to devise a way to keep bats in captivity so that they may be domesticated to farm uses.

The bat is a nocturnal animal, hiding in dark caves in the daytime. Some varieties migrate with the seasons, while others hibernate, hanging suspended from roofs of caves by their hooked claws, sleeping for periods as long as ten weeks. They never build nests.

As soon as young are born—never more than two to a pair—they attach themselves to the breast of the mother bat, remaining with her until they have gained strength enough to fly.

Converted Auto Mirror Is Useful in Rowboat

TO A person rowing a boat, a knowledge of what is going on behind him is even more important than to one driving an automobile, and therefore the automobile mirror has been put to this second use.

Attached to the side of the boat immediately in front of the rower and tilted to reflect images at the proper angle, the mirror affords a good view of what is ahead, making it easy to keep the boat in its straight course and avoid collisions.

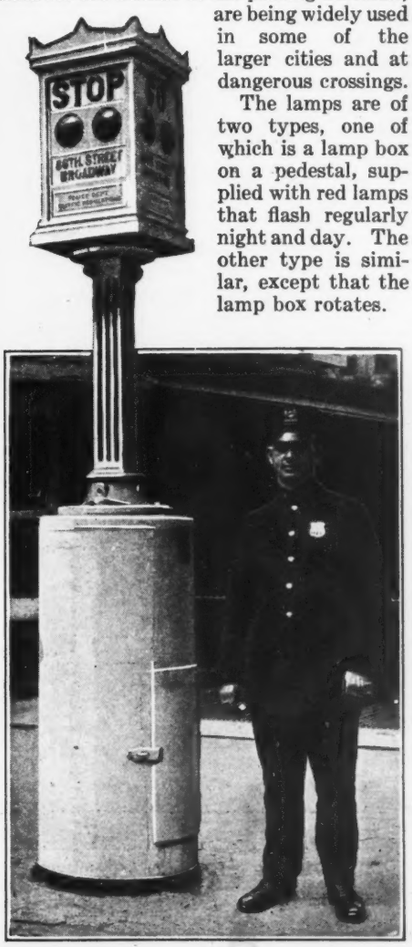
Nearly Two Billion Stars

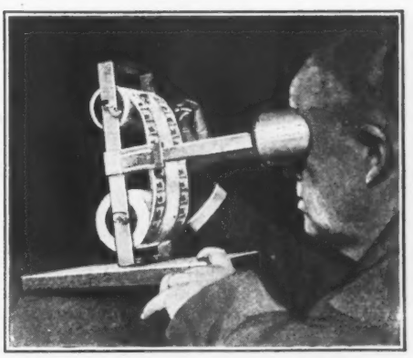
LATEST estimates made by scientists of the Royal Observatories at Greenwich, England, are that there are approximately 1,600,000,000 stars. Of this number between 3000 and 4000 are visible to the unaided eye. The late Franklin Adams made a set of 206 photographs covering the entire sky from which it was possible to estimate the number of recorded stars at about 55,000,000.

"Talking Lamps" Warn Autoists of Danger

"TALKING" signal lamps, with complete traffic regulations printed on their sides for the benefit of the passing motorist, are being widely used in some of the larger cities and at dangerous crossings.

The lamps are of two types, one of which is a lamp box on a pedestal, supplied with red lamps that flash regularly night and day. The other type is similar, except that the lamp box rotates.





Workman Studies Expert's Actions in Movie

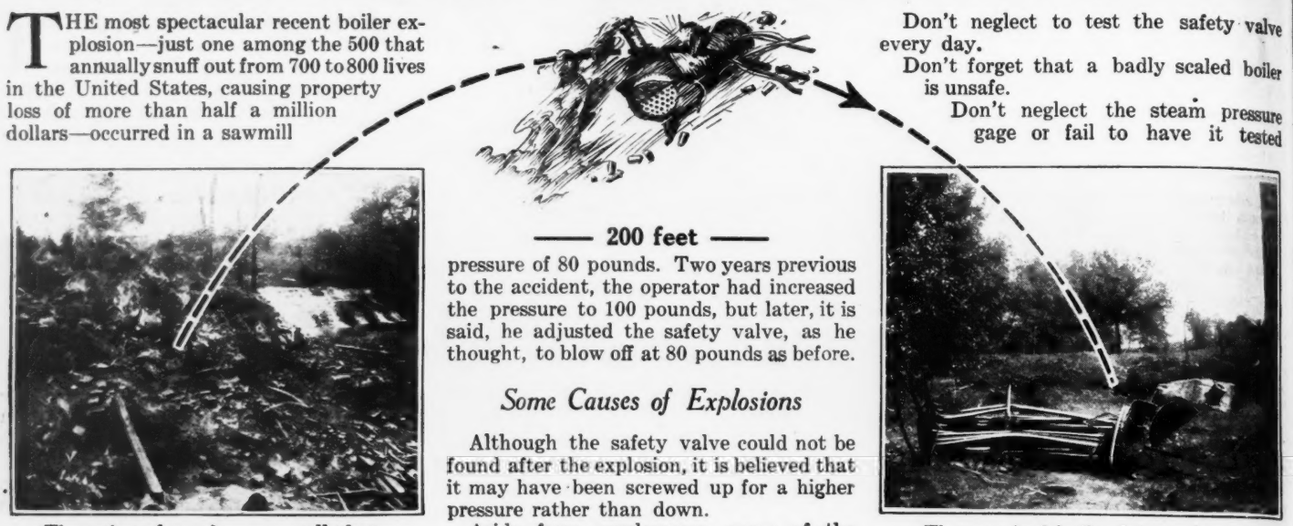
IN ORDER to instruct workmen in the best methods of manipulating a machine or performing an industrial operation, Major Frank B. Gilbreth, noted efficiency expert, has perfected a small stereoscopic movie machine that enables the workman to study each movement of an expert in minute detail.

When a man accomplishes results in a minimum of time with the least exertion, he is termed an expert. To educate other workmen to become experts, this man can be used as an example. Stereoscopic motion pictures are taken of the expert in action and printed upon a paper roll. To each of the separate pictures is attached a caption that calls attention to the faults or correct actions of the individual in the picture. Thus a study of an expert's actions can be made by the less experienced man by observing the film through a stereoscope while continually passing before the eye the successive movements that go to make up a complete operation.

Each device for taking these pictures includes a microchronometer, or rapid clock, that records the time on each picture, which shows paths of motion, as well as the exact time taken.

Why Boilers Explode—This One Traveled 200 Feet

THE most spectacular recent boiler explosion—just one among the 500 that annually snuff out from 700 to 800 lives in the United States, causing property loss of more than half a million dollars—occurred in a sawmill



The price of carelessness—all that remained of the sawmill

The wrecked boiler lying where it landed, 200 feet from the mill

at Le Roy, Ohio, when the shattered boiler was hurled high across a stream for a distance of 200 feet from its foundation.

The boiler was of the horizontal tubular type, 30 years old. It was designed for a pressure of 80 pounds. Two years previous to the accident, the operator had increased the pressure to 100 pounds, but later, it is said, he adjusted the safety valve, as he thought, to blow off at 80 pounds as before.

Some Causes of Explosions

Although the safety valve could not be found after the explosion, it is believed that it may have been screwed up for a higher pressure rather than down.

Aside from carelessness, some of the chief causes of boiler explosions that could be avoided are summed up by experts in a few simple "Don'ts," the most important of which are:

Don't fail to test the water gage every day to make sure that the boiler contains the proper amount of water.

Don't neglect to test the safety valve every day.

Don't forget that a badly scaled boiler is unsafe.

Don't neglect the steam pressure gage or fail to have it tested occasionally—say, about once every year.

Don't try to raise steam in a cold boiler too quickly.

Don't depend on others to see that everything is all right.

Master Gear Molds Perfect Gear Teeth in White Hot Blanks

INCREASED accuracy and greater wearing qualities in the production of toothed gears of all types have been achieved recently by the invention of a revolutionary machine that forms gear teeth by rolling a plastic, white hot gear blank in mesh with a water cooled, accurately formed master gear.

Gear Teeth Hot Rolled

Replacing the usual method of cutting the gear teeth cold from blanks in milling machines, the new hot rolling process is said to be one of the most important developments in the machine tool industry in a decade. Hot rolled gears already have been adopted by several automobile manufacturers, and are said to represent an important saving in time and material.

The drop forged steel blanks from which the gears are made are similar to those supplied to standard gear cutting machines, except that they are from 20 to 40 per cent lighter, since the rolling process uses all the material in the blank, whereas the cutting process necessitates cutting away a large amount of the material.

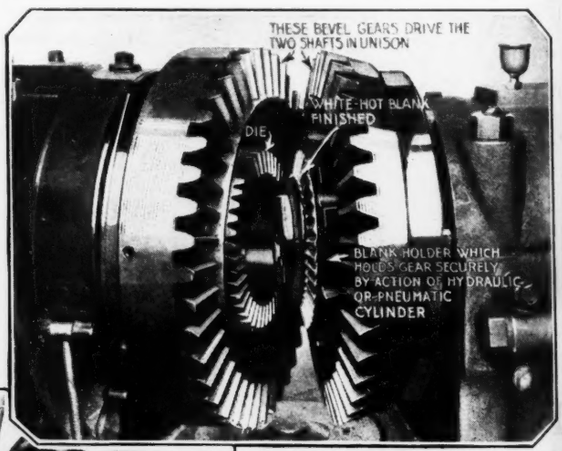
The blank is heated white hot in a small gas furnace at one end of the machine. Then it is mounted in the machine and a gear die is gradually brought into mesh with it as the two rotate in unison, the die slowly meshing deeper and deeper until the hot blank is a perfect mate for the die. In twenty seconds the job is finished and the machine is ready for another blank.

The machine has four bevel gears, as shown in the close-up view on this page. Two large gears drive the two shafts of the machine in perfect unison. Inside one of the big bevels is the die gear and opposite, meshing with it, is the finished hot rolled gear.

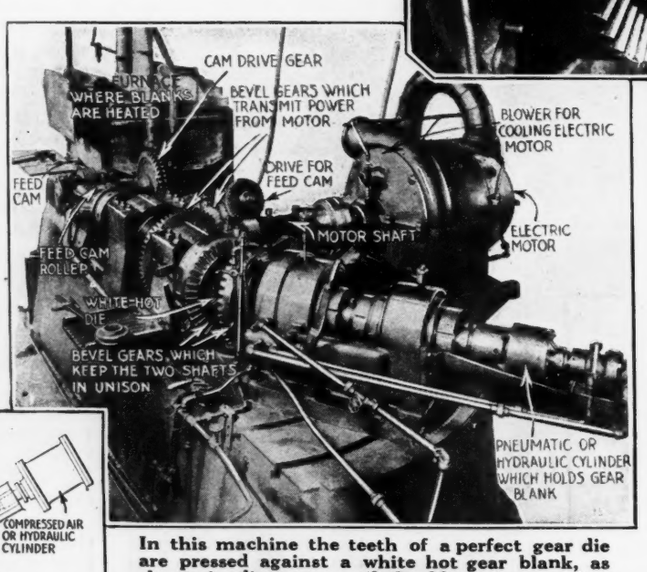
When the hot blank is placed in the machine, it is held securely by the action of a hydraulic or pneumatic cylinder located on the end of the shaft upon which the blank is mounted. The shaft that turns the die gear is connected by bevel gears with an electric motor.

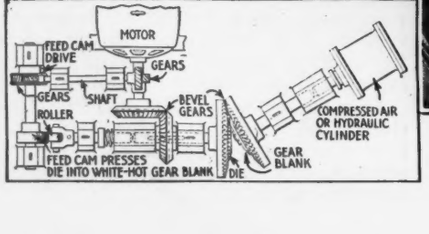
The other end of this shaft has a large roller against which the feed cam bears, and is rotated by the large drive gear. This gear is operated by auxiliary gearing from the motor shaft.

The motor does not run continuously in one direction, but instead, makes a fraction more than one revolution, then reverses to make a little more than a revolution in the other direction. The movement in one direction is slightly less than in the other so that no two revolutions bring the same teeth of the die into action.


THESE BEVEL GEARS DRIVE THE TWO SHAFTS IN UNISON
WHITE-HOT BLANK FINISHED
DIE
BLANK HOLDER WHICH HOLDS GEAR SECURELY BY ACTION OF HYDRAULIC OR PNEUMATIC CYLINDER

Close up of the gear rolling mechanism, showing large bevel gears that drive the die and blank shafts in perfect unison, and, within, the die and finished gear blank


CAM DRIVE GEAR
FURNACE WHERE BLANKS ARE HEATED
BEVEL GEARS WHICH TRANSMIT POWER FROM MOTOR
BLOWER FOR COOLING ELECTRIC MOTOR
DRIVE FOR FEED CAM
FEED CAM
MOTOR SHAFT
ELECTRIC MOTOR
FEED CAM ROLLER
WHITE-HOT DIE
BEVEL GEARS, WHICH KEEP THE TWO SHAFTS IN UNISON
PNEUMATIC OR HYDRAULIC CYLINDER WHICH HOLDS GEAR BLANK



In this machine the teeth of a perfect gear die are pressed against a white hot gear blank, as shown in diagram, until the blank is a perfect mate for the die

A 5000-Mile Trip to the Arctic in a Flying Boat

IN THE most complete and luxurious flying boat ever constructed, six nationally known American sportsmen, accompanied by four newspaper and movie men and a crew of three, will fly from New York to the Arctic Circle next summer in an effort to establish an aeromarine line that will bring New York within 72 hours of the Arctic.

The Sailing List

The sportsmen who have said they will make the trip are I. M. Uppercu, president of the Cadillac Motor Car Co.; Howard E. Coffin, president of the National Aeronautical Association; Harold H. Emmons, president of the Detroit Board of Commerce; Dr. James W. Inches, police commissioner of Detroit; William E. Metzger, president of the Detroit Athletic Club, and Charles Redden, president of Aeromarine Airways.

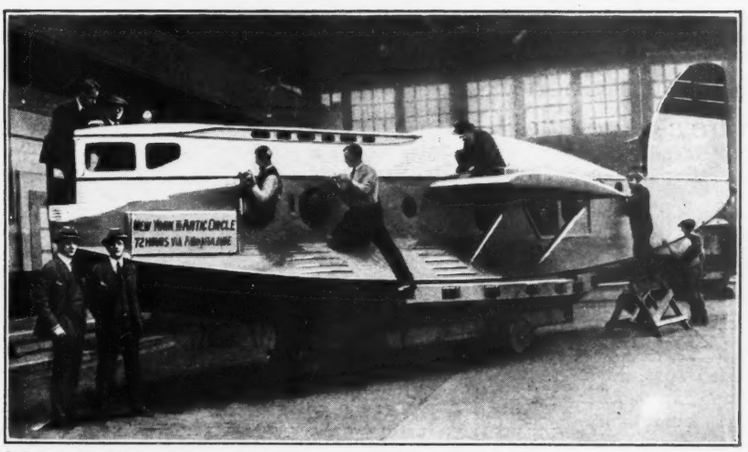
The flying boat, for which the hull and cabin are now complete, will have a wing spread of 104 feet, and will be driven by two 400-horsepower Liberty engines. The entire machine will weigh 7½ tons, and will attain a maximum speed of 100 miles an hour.

An Infinite Variety of Scenery

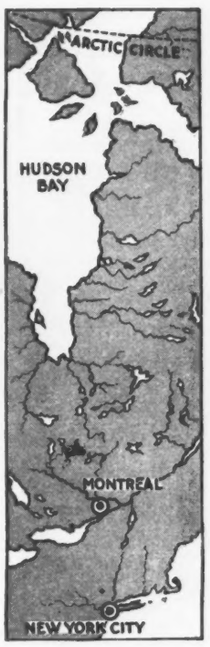
The journey of 5000 miles will take from two to four weeks, since it will be made by easy stages. Leaving New York, the boat will go to Montreal, and from there will follow the Ottawa River and a chain of lakes northward through Quebec to James Bay, thence through Hudson Bay to the Arctic Circle, where the sportsmen will enjoy themselves shooting caribou and other big game.

Complete equipment, an electric range for cooking, convertible beds that turn into chairs in the daytime, and an inclosed observation compartment at the nose of the machine will be just a few of the conveniences embodied in the boat. The radio outfit will have both the loudspeaker and head phones. Several broadcasting stations have arranged to give special radio programs for the sportsmen, supplying continuous entertainment throughout the trip.

The epoch-making air voyage was conceived by C. F. Redden who, while flying over Quebec recently, became impressed with the possibility of flying over water to the Arctic Circle. He declares that the journey involves no danger and will provide novel sport for the tired business man.

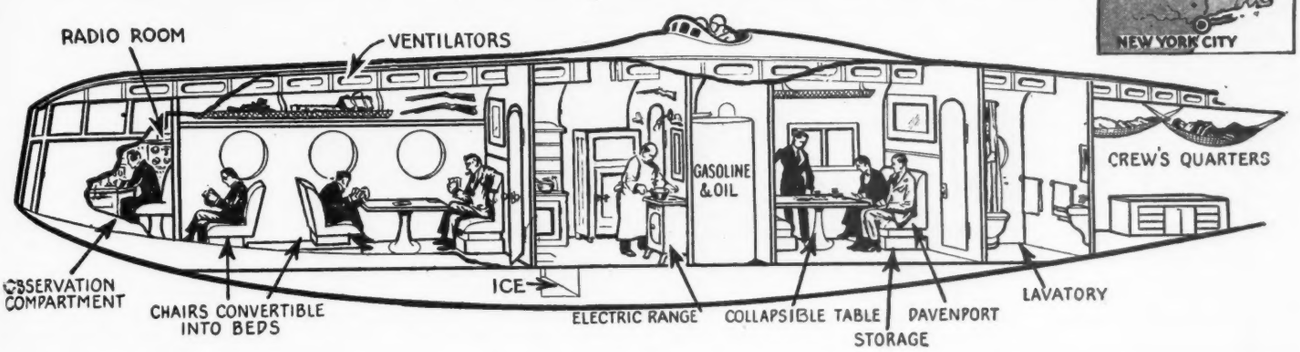


© Aeromarine Airways, Inc.



Businessmen-Hunters to Travel in Ship of Luxury

Workmen are shown above putting the finishing touches on the spacious flying boat in which six American businessmen-sportsmen will travel from New York to the Arctic Circle over territory shown on the map at the right. The diagram below shows arrangement of cabins



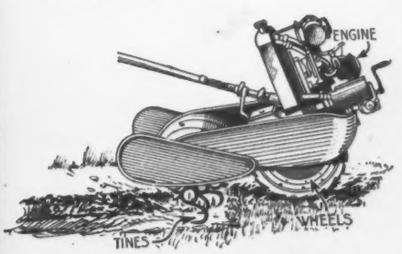
Plow, Harrow and Roller Combined

A ROTARY soil tiller that performs simultaneously the operations of plowing, harrowing, rolling, and disking, has received the approval of an English horticultural society.

The motive power is supplied by a single cylinder engine, giving 4.17 horsepower at 1800 revolutions a minute. The power is transmitted through worm gearing to a set of eight spring tines located side by side on a shaft extending across the machine. These tines, rotating at high speed, churn up the soil to a depth depending upon the setting of a shoe in the rear, which can be adjusted in five different positions.

Part of the power is transmitted to a pair of wheels on either side of the machine, which serves to move the tiller forward at any desired rate. The machine is kept in line by the operator, who walks in the rear of it.

When it is desired to use the implement as a power plant, it is necessary merely to throw out the clutches and connect the engine with the machine by belting. The entire machine weighs only 350 pounds.



By turning a handle in this combination power plow, harrow, disk and roller, the operator controls its movements. In diagram, note tines that rotate at high speed, churning the soil

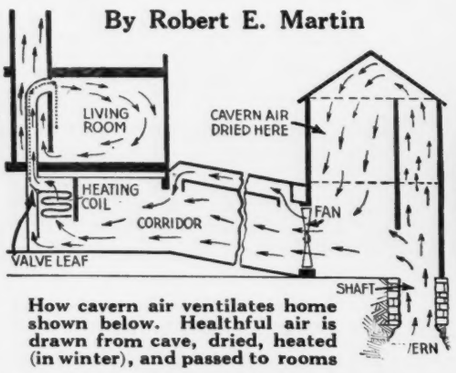
Science Opens Wonder Caves to Tourists

Marvelous Lighting Systems, Safe Underground Paths, Automobiles and Good Roads, Combine to Exploit Nature's Age-Old Cavern Architecture

By Robert E. Martin

IN THE Shenandoah Valley of Virginia, where many of the historic battles of the Civil War were fought, science is putting the finishing touches on marvelous works of underground architecture begun by nature millions of years ago, and is converting them into scenic attractions of rare beauty to entice the touring public.

Electric lights, tunneled pathways, automobiles, good roads and many other modern achievements are being combined in one commercial project, backed by a rapidly growing organization known as the "Cave Men's Club of America," to draw nature lovers from all parts of the world to the portals of natural caves surpassing in size, beauty, and perfection anything that human builders have ever done.



How cavern air ventilates home shown below. Healthful air is drawn from cave, dried, heated (in winter), and passed to rooms

O. Josh Wilson, oldest cave guide, at Mammoth Cave, Ky., has shown the caverns to 36,000 visitors, handling fees aggregating $108,000

The only home in the world ventilated by cave air is Limair, owned by T. C. Northcutt, of Virginia. At the extreme right is an air shaft with corridor leading cave air from it to the residence

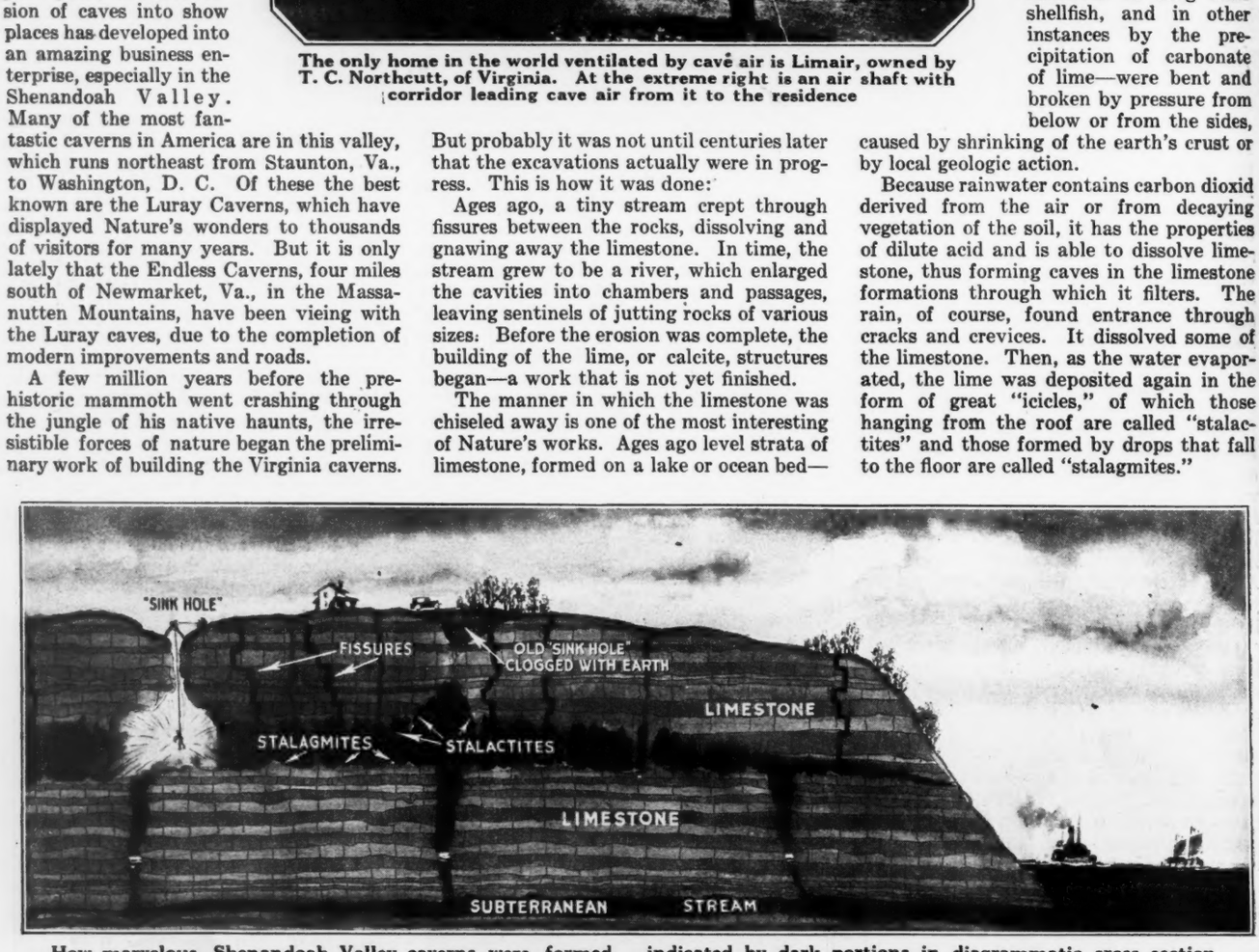
Natural caverns, with their glistening stalactites and stalagmites—long varicolored and rock-like icicles of crystal—have been exploited in a haphazard way for centuries. But during the past year, the conversion of caves into show places has developed into an amazing business enterprise, especially in the Shenandoah Valley. Many of the most fantastic caverns in America are in this valley, which runs northeast from Staunton, Va., to Washington, D. C. Of these the best known are the Luray Caverns, which have displayed Nature's wonders to thousands of visitors for many years. But it is only lately that the Endless Caverns, four miles south of Newmarket, Va., in the Massanutten Mountains, have been vieing with the Luray caves, due to the completion of modern improvements and roads.

A few million years before the prehistoric mammoth went crashing through the jungle of his native haunts, the irresistible forces of nature began the preliminary work of building the Virginia caverns. But probably it was not until centuries later that the excavations actually were in progress. This is how it was done:

Ages ago, a tiny stream crept through fissures between the rocks, dissolving and gnawing away the limestone. In time, the stream grew to be a river, which enlarged the cavities into chambers and passages, leaving sentinels of jutting rocks of various sizes. Before the erosion was complete, the building of the lime, or calcite, structures began—a work that is not yet finished.

The manner in which the limestone was chiseled away is one of the most interesting of Nature's works. Ages ago level strata of limestone, formed on a lake or ocean bed—in some instances by the skeletons of long dead shellfish, and in other instances by the precipitation of carbonate of lime—were bent and broken by pressure from below or from the sides, caused by shrinking of the earth's crust or by local geologic action.

Because rainwater contains carbon dioxid derived from the air or from decaying vegetation of the soil, it has the properties of dilute acid and is able to dissolve limestone, thus forming caves in the limestone formations through which it filters. The rain, of course, found entrance through cracks and crevices. It dissolved some of the limestone. Then, as the water evaporated, the lime was deposited again in the form of great "icicles," of which those hanging from the roof are called "stalactites" and those formed by drops that fall to the floor are called "stalagmites."



How marvelous Shenandoah Valley caverns were formed. Strata of limestone, broken by the shrinking of the earth's surfaces, are attacked by rain water containing carbon dioxid, which dissolves the limestone strata, chiseling out caves indicated by dark portions in diagrammatic cross section above. Dissolved lime drips into the form of great "icicles" called "stalactites," which hang from the roof, with corresponding "stalagmites" on the floor of the cave

Photos © J. D. Sickler

An Underground "Ballroom"

THE entrance to the magnificent "ballroom" of the Luray Caverns is shown at left. With smooth paths, guard rails, and electric lights, caves such as this have been made as safe as hotels for tourists

Through the underground passages eaten out by the acid, water runs from the surface at times. The Shenandoah Valley is full of potholes that, lacking surface drainage, quickly empty rain water into underground water courses until cracks in the rock beneath them become filled with earth or stalactitic material. At one time a hole that had held water for many years suddenly opened as if some one had pulled out the stopper, and a small lake disappeared with a mighty roar into the bowels of the earth.

Nature's Drainage System Makes Caves

A cave system in limestone is really a drainage system such as formed by rivulets, creeks, and rivers. If a cave is dry, it means that the stream that formed it has lowered its bed by erosion and that the cave waters have found a lower level. In many caves, several levels—deserted creek beds—can be found. In most limestone caves water can be found, though hidden many feet below the level of the cave in an underground stream that flows to the sea. And, if no water is found in the bottom of a cave, there is a mud sump with marks showing where the water has run out.

The newly commercialized Endless Caverns and the Shenandoah caverns, three miles south of Mount Jackson, have become tremendously popular. More than 10,000 persons paid admission fees during the first 10 weeks after the Shenandoah caverns were made accessible to tourists. The perfect highway from the Valley Pike to the entrance of the Endless Caverns has drawn many more thousands, and smaller caves in the vicinity have reaped some of the profits.

$250,000 Spent to Exploit Caves

Improvements in the Endless Caverns, representing an investment of more than a quarter of a million dollars, include a great stone restaurant, a stone ledge over the entrance, an adjoining farm that supplies the restaurant, an observation tower and searchlight on a near-by hill, a power plant that floods the dark underground passages with radiance, and a proposed stone hotel.

From the moment you follow the guide into a narrow passage that appears at first to be a blind alley, but turns out to be an entrance, you are dazzled by the glittering splendor of delicate and massive formations, a riot of exquisite coloring.

(*Continued on page 62*)

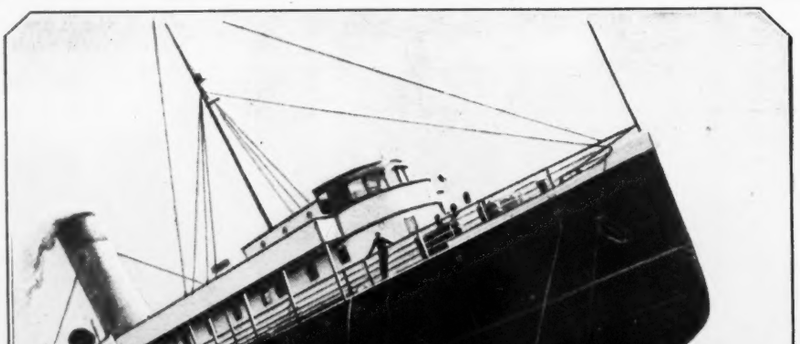
THIS photograph of the spacious "Saracen's Tent" in the Luray Caverns, gives an idea of the massive underground formations on which Nature has worked for centuries. Note size of gorgeous stalactites hanging from the dome and of the huge pillar at the left, as compared with the two men in the photograph. The cave's natural beauty is enhanced by ingenious lighting

Trick Forces Tide to Lift Steamer from Rocks

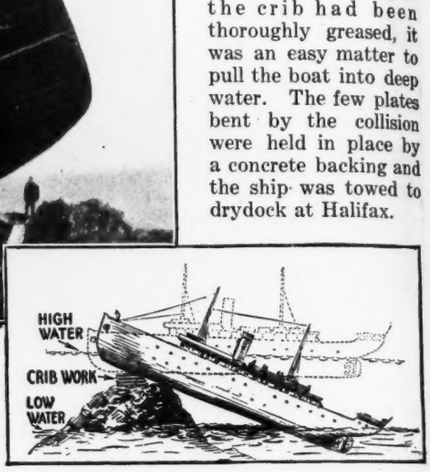
WITH the aid of a 20-foot tide and an ingeniously constructed cribbing, engineers recently succeeded in floating the steamer "Empress" from the rocks in the Bay of Fundy, after every effort to pull the vessel into deep water with tugs had failed.

The Canadian Pacific steamer was on her regular run in the bay when she poked her nose high on a ledge of rock in St. John harbor in such a way that a point of the ledge became firmly hooked into plates on the ship's bottom.

When tugs attempted to pull the steamer away, they served merely to fasten the rocky hook more firmly into the ship.



Steamer "Empress" on the rocks, showing workmen constructing cribwork that lifted her free of the ledge, as in diagram



It was decided that the only way to float the steamer was to raise her entirely off the ledge. Therefore, at low tide, a portion of the rock was blasted from beneath the bow, and there a cribbing was constructed so that as the stern rose with the rising tide, the weight of the ship was thrown on the cribbing. Finally, at high tide, the hull was lifted clear of the ledge, and the bow rested on the cribbing. Since the top of the crib had been thoroughly greased, it was an easy matter to pull the boat into deep water. The few plates bent by the collision were held in place by a concrete backing and the ship was towed to drydock at Halifax.

Caverns Open to Tourists

(*Continued from page 61*)

Perhaps most impressive of all sights is the Diamond Lake in the Endless Caverns. You reach a point in the caverns where you see a cleft about two feet high and about three feet from the floor. Suddenly the lights go out and the entire cavern is in darkness.

"Face the end of the passage, please," orders the guide. You comply, wondering what is coming. In a moment there is a "click," followed by a flood of ruby-colored light that turns Diamond Lake into blood red water, reflecting countless rubies in the banks and ceiling over the tiny crescent shaped lake.

Fantastic Forms and Colors

Once again the cavern is in darkness; then soft yellow lights transform the lake cavern into a jeweled castle of yellow diamonds. Then green lights, creating an emerald lake that excites gasps from the spectators who remember Diamond Lake as one of Nature's most beautiful scenic spots.

There are other scenes in the Endless Caverns just as fantastic—the Palace of Fairies, where a forest of crystal formations suggests all manner of elfin, fairy, and goblin-like figures, enhanced by skilfully placed electric lights. There are formations of pure milky white, delicately colored stalactites and stalagmites of tints and shades rangeing from reddish brown (made by iron compounds) to soft gray blue (caused by the presence of manganese). There is the Hall of Giants, where tremendous stalactites and stalagmites lie prostrate, one of them weighing 400 tons and believed to have fallen nearly 4000 years ago.

Perhaps the most awe inspiring of all is a milk white specter standing guard over what is known as "Pluto's Chasm," a rift 40 feet deep, and 500 feet long. Dainty shawls of translucent calcite, falling in graceful folds ornamented with a narrow band of reddish brown; cascades of glistening white, terraces, pools of crystal clear water, countless formations of white and colored calcite formations, combine to make the chasm one of the most beautiful pieces of underground architecture in the world.

There are endless wonders in caves. To some persons the silence is ghastly; to others it is soothing. It is broken only by the dripping of water or the rolling of a pebble. Bats hang in clusters from the wall; sometimes you run across nests of wild animals, often containing bones; seeds brought in by birds or beasts send up shoots of pallid white; colorless translucent cave crickets hop about with proverbial liveliness; ghostly eyeless fishes and crabs swim about in the underground streams.

In historical interest and in size Mammoth Cave, Ky., surpasses all known caverns. It was made a show place as early as 1816, passing into various hands and finally to Dr. John Croghan, who bought it and 2000 acres of surrounding land for $10,000. O. Josh Wilson, oldest guide there, has shown the caves to no less than 36,000 people, receiving fees estimated at $108,000. Saltpeter miners, tuberculosis colonists, mushroom farmers, Indians, theatrical stars, singers, and even presidents, have visited the place even though in the early days they were forced to go on mule-back.

Other famous caverns are Wyandotte Cave in Indiana; Penn's Cave, near Centerhall, Pa.; Washington's Masonic Cave in northeastern West Virginia, where the first president is reputed to have held Masonic meetings; the caves of the Winds at Niagara Falls and in Colorado, and the caves of Arizona, New Mexico, and Ohio. All of these fall under the classification of exploited caves from which a business mounting into millions of dollars is derived.

But the unexploited caves are the ones that are attracting the interest of the Cave Men's Club of America.

At every opportunity members of the club seek out little known caves, enter by ladder or rope, and explore the unknown depths, risking their lives and getting from the adventure thrills they feel are great enough to justify their trouble.

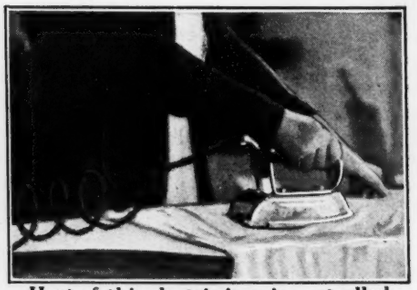
Electric Iron Can Be Set at Any Temperature

USING a new "even heat" electric iron, the housewife can set her iron for low, intermediate, or high heat; thus regulating the temperature to give the best results on the particular material being ironed.

When a control button is set for low heat, a thermostat consisting of a laminated metal rod is so bent that any temperature above 150 degrees will cause a further bending of the rod and will break the circuit until the excess heat has been consumed and the rod contracts to its original position, when the current is again permitted to flow.

When heat passes desired temperature, bending metal rod breaks the circuit

When set for high heat, the thermostat acts at a temperature of 400 degrees. Any intermediate setting places a definite pressure on the thermostat and causes the current to be shut off at whatever temperature is demanded by the work in hand.



Heat of this electric iron is controlled by pressure on a button

Will Women Athletes Win Men's Crowns?

Former Woman Swimming Champion Says Masculine Title Holders Must Look to Their Laurels—Girl First to Smash Record

By Ethelda Bleibtrey

Former Amateur Swimming Champion of the World

FOR the first time in history a woman athlete, in competition with a man, has broken a world's athletic record.

When Sybil Bauer, an 18-year-old girl student at Northwestern University and member of the Illinois Athletic Club, recently swam 440 yards backstroke in six minutes, 24 4/5 seconds, she not only smashed the world's record for that event, held by her own teammate, Harold Krueger, but she issued a challenge in behalf of all womankind against the supremacy of man in the world of sports.

An Era of Women Champions

In itself, this college girl's feat might be of only passing importance were it not for the fact that hundreds of women are crowding to the front in sports, creeping closer year by year to the championship laurels that until now have been worn exclusively by men in all lines of athletics. I predict that Miss Bauer's swimming record definitely marks the beginning of an era when the world's sport crowns will fall, one by one, before the conquests of the "weaker sex," and that eventually women will wear as many of these prizes as men.

I believe this so thoroughly that I am now coaching a class of superswimmers at the Ambassador Hotel in Atlantic City directly preparatory to trials for some of these world records.

The tremendous advance of women in athletics during the past twenty years, and especially in the past five years, has been a thrilling drama to me. Let us analyze some of the records in which women approach the marks set by men:

© U. & U.

Ethelda Bleibtrey—Former amateur woman swimming champion of the world and now coach of a class of women swimmers, some of whom, she predicts, will capture world's records now held by men

When I first began to swim, a mark of one minute and seventeen seconds was a splendid one for women swimmers competing in the 100-yard event. They have gradually cut down that mark until they are approaching a time of one minute and soon they will be down to the time of 56 seconds, the record set by men. Other backstroke marks, besides that for the 440 yards, will be among the first to fall.

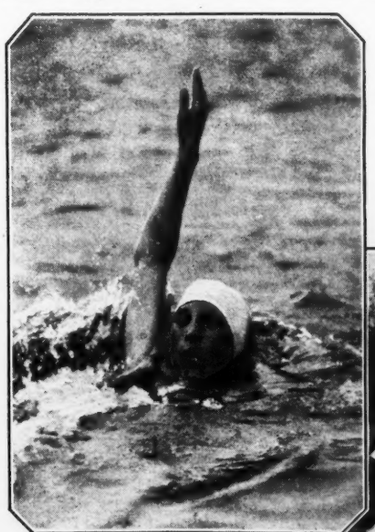
In golf, women are slowly but surely driving to the front. Just how near they are to the excellence of men in this vastly popular game may be ascertained from the fact that the longest drive by a man is 341 yards, the record set by Abe Mitchell, the British golfer. Yet Glenna Collett, an 18-year-old girl champion, who has not yet reached her full powers, has actually driven a golf ball 313 yards!

Tennis Marvels Vie with Men

In tennis, one of the first games women took up, man's supremacy is being threatened. I am quite sure that Molla Mallory or Suzanne Lenglen could defeat all but two or three of our best men players. Mademoiselle Lenglen's drives, according to Vincent Richards, the young tennis marvel who has played against her, are as hot and as difficult to handle as any man's. Experts predict that Miss Helen Wills, 15-year-old star, will eclipse both Mrs. Mallory and Mademoiselle Lenglen.

Englishwomen have become experts in hockey, one of the roughest of games. Only a short time ago the Sheffield women's soccer team from England played Philadelphia Field Club Men's team at Philadelphia, Pa., and the latter, playing at full speed, were barely able to scrape through by a margin of one point. American girls also are proficient in hockey, and in ice racing. Miss Gertrude Mohler attains speed very close to that of men skaters.

Women are steadily gaining on men in basketball, offsetting man's natural superior weight by their greater natural agility and team work. Even in baseball the Kansas City Bloomer Girls' team recently played one of the best semi-professional men's teams of New Jersey and emerged victorious.

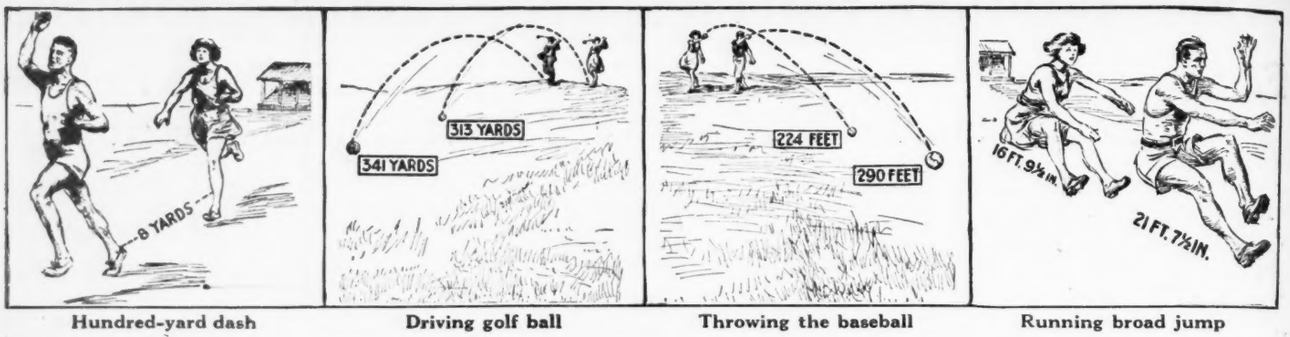


The first woman in history to capture a world's athletic championship from a man — Sybil Bauer, 18-year-old college girl, setting a new record for the 440-yard backstroke swim

Flying tackles, line bucks, forward passes—all the grueling plays of the gridiron—are enjoyed by these girl football players at George Peabody College, Nashville, Tenn.

A golf champion at 18, Glenna Collett has driven a golf ball 313 yards, or only 28 yards less than the world's record drive by Abe Mitchell, famous British golfer

Records that Show Women Athletes Are Running Close Second to Men



Hundred-yard dash | Driving golf ball | Throwing the baseball | Running broad jump

And women are now throwing themselves into a supposedly exclusive sport for men. The football team of the George Peabody Teachers College of Nashville, Tenn., attracted considerable attention last season.

The first real track meet for women was held last summer in New York. Yet the marks set compare favorably with those of young men of the same age and development. Schoolgirls can now run the 100-yard dash in 12 seconds or better, as compared with 10 1/5 seconds for boys of the same age; Miss Rhea Riedel threw a javelin 98 feet! Maude Rosenbaum threw a basketball 94 feet two inches; and Eleanor Churchill a baseball 224 feet four inches, as compared with a man's record of 290 feet. Ellen Hayes hopped, skipped and jumped 33 feet six inches, and Maud Devore broad jumped 16 feet 9½ inches, or only four feet 10 inches less than the world record set by man.

Just a few weeks ago, four girls of the Valcour Club, without preliminary coaching, ran a 440-yard relay, each running 110 yards in 55 3/5 seconds, a really fast time for boys of their age.

Will women ever approach men in throwing weights and other feats of sheer strength? One girl, Margaret Mitchell, already has "put" a 12-pound shot 28 feet four inches, and is likely to shatter that mark soon. A high school boy of her age would do well to heave it 35 feet.

Sybil Bauer's swimming record, of course, will spur women on to accomplish greater athletic achievements. What she did, others can do, and in a few years I believe you will see many of the marks set by men falling before sturdy women athletes.

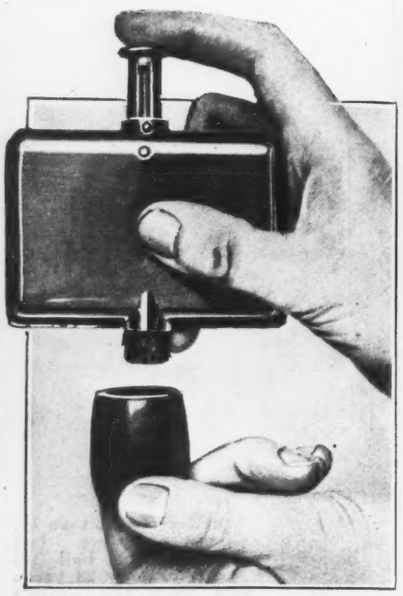
Are You Getting the Right Kind of Exercise?

IMPORTANT new truths about exercise in relation to your particular job or profession—facts that you can use every day in the year to keep yourself fit—will be revealed for the first time in next month's issue of POPULAR SCIENCE MONTHLY by a national authority on the subject, Dr. C. Ward Crampton, aide to Secretary of War Weeks in his nation-wide campaign for better American manhood.

Doctor Crampton will tell you exactly what sort of exercise you need—whether you are a business executive, a clerk, a mechanic, or an outdoor worker—and why you need it. And he will give you some simple tests that will enable you to determine whether you are keeping your physical condition up to normal.

Pocket "Gun" Shoots Tobacco into Pipe

AMONG recent novelties for pipe smokers is a pocket "gun" holding eight tobacco cartridges. The case is equipped with a plunger that forces the tobacco from the cartridge and rams it into the pipe. When not in use, the plunger rests in the groove that separates the two layers of tobacco cartridges.



A plunger forces cartridge of tobacco into the pipe

"Feeler" Car Records Bridge Clearance

When "feelers" on this queer looking railroad car strike the sides or top of bridge or tunnel, they record clearance in feet. Another device measures curvature of rails

A SPECIALLY designed railway car, which not only measures accurately the clearances of bridges and of other objects along the line, but also records the curvature of rails and the height of one rail above the other where tracks are banked at curves, is being operated by the Pennsylvania Railroad.

The car makes its record while traveling at four miles an hour. It has two templets, one of which has attached to it a number of hinged extensions or feelers of steel, spaced six inches on centers. In passing a bridge, the feelers strike the sides and top of the bridge and are deflected to the angle that permits clearance.

The amount of this deflection is recorded automatically. For higher bridges a second templet is raised by a jack screw and similar readings are taken.

The movement of a pendulum located in the center of the car, shows the height of one rail over another, while still another arrangement shows the curvature of the track.

Millions of Tons of Fuel Lie Unused in Peat Bogs

WITH his coalbin depleted of its last shovelful, W. T. Cox, state forester of Minnesota, went out into his back yard during the past winter and dug up enough peat to keep him in fuel. In so doing he set an example for thousands of other families in his state, who "mined" enough of the long overlooked substitute to tide them over the coal shortage.

In 65 of the 86 counties of Minnesota, according to Cox, there are more than 6,000,000 acres of peat lands. He says that nearly every farmer in the state could be independent of the coal dealer if he would only consume the substitute used so widely in Europe.

Why worry about a coal shortage when you can dig peat out of your yard and burn it in the furnace? Above is part of the winter fuel supply of W. T. Cox, Minnesota state forester. Blocks of peat that he spades from his yard, as shown at the right, are stacked in piles to dry for several weeks until needed for fuel

Billions of Tons Available

And Minnesota is not the only state in the Union thus neglecting its fuel resources, for the total deposits in the United States are said to contain 14,000,000,000 tons—enough to supply Europe, at its present rate of consumption of 20,000,000 tons a year, for 700 years. A large part of this peat is well adapted to power production. Peat ashes also are useful in tanning leather and in making antiseptics, cement, and fertilizer.

Peat is a spongy substance, found in almost every bog or marsh. It represents one of the phases in the slow decay of vegetable matter through the ages. When plant remains fall upon drained soil, they are promptly attacked by bacteria and soon disappear. But when they fall into water, the acids formed retard the decaying by destroying bacteria, and a large proportion of the carbon matter in the plant material is saved. In color, peat varies from light brown to black, and in consistency from that of bran mash to that of clay. Most coals were transformed from peat.

Some advance has been made in the recovery of commercial peat in other states than Minnesota. In the great Dismal Swamp, in Virginia, for example, peat deposits covering almost 1000 square miles to a depth of from 15 to 20 feet are being mined by two large corporations that were awake to its marketable value.

The harvesting of peat is still generally done with a hand spade with sides and back forming a mold. Blocks removed by this tool are placed in piles in the air, and are turned time after time. When dry, they are ready for burning. In Europe a pressure method of drying peat in large quantities has recently been invented.

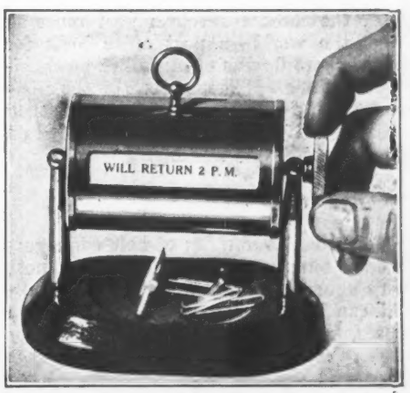
In its natural state peat has not the heat capacity of coal, but when pulverized to a fine flour and blown under a boiler, it is an excellent fuel for commercial work. The natural peat blocks, however, can be used effectively in a small furnace, stove, or fireplace.

Print Radio Newspaper "On the Run"

THE feat of editing and printing 10,000 copies of the Yankton (S. Dak.) *Press and Dakotan* in 23 editions in 23 towns in the course of a 300-mile automobile trip was recently accomplished with the aid of radio.

From a radio car fitted with complete receiving apparatus, up-to-the-minute state news and Associated Press despatches sent by Yankton College wireless station, were received. This news, together with local news, was edited, set up, and run on a multigraph press in a press car. Type was set while a stop was being made and the next edition was run off while the cars were on their way to the next town.

Here is the complete automobile newspaper plant. At left is radio car showing operator receiving news despatches, and at right is automobile multigraph plant



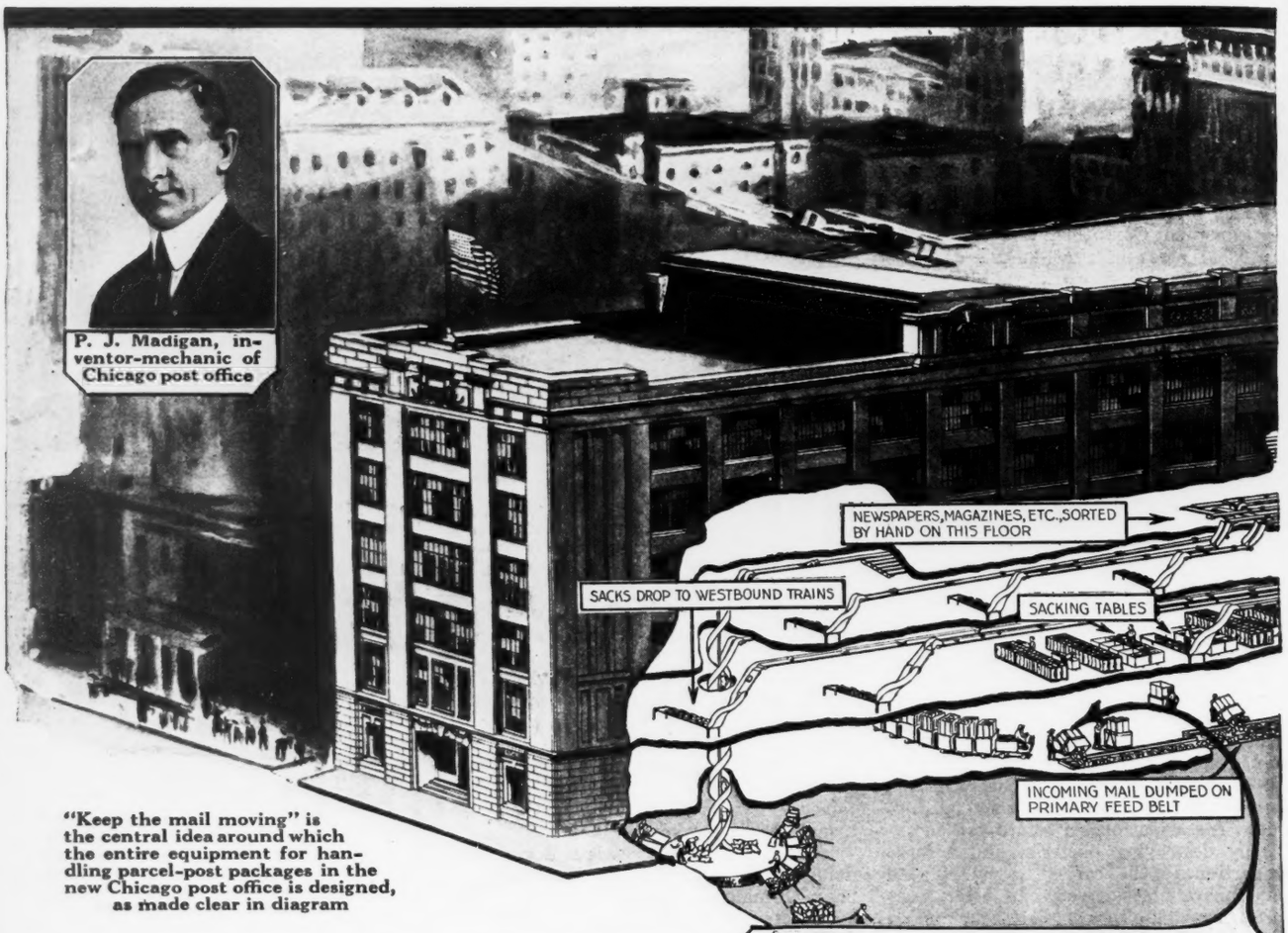
A Desk "Office Boy"

A SIMPLE office desk device that does the work of office boy or secretary in informing visitors whether the business executive is absent, where he is, and when he may be expected to return, consists of a stand that supports a drum in which is a rotating cylinder. Upon this cylinder are 17 readings that cover periods of time in the ordinary business day. The departing executive need only turn a knob until the proper reading appears.

When not used for this purpose, it forms a convenient paper holder and tray for pens and paper fasteners.

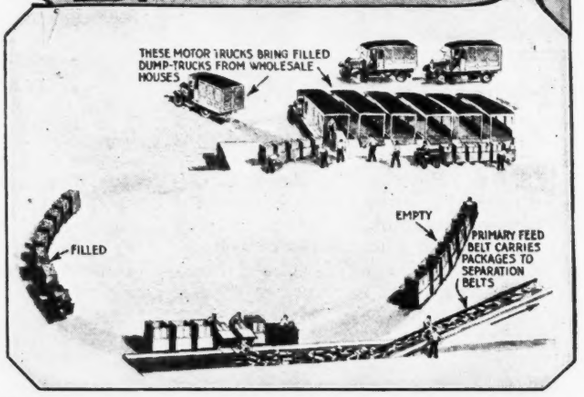
THE Editor will be glad to supply, wherever possible, names and addresses of manufacturers of devices mentioned in this issue.

Postal Inventor Devises Miles of Belt Conveyors to


NEWSPAPERS, MAGAZINES, ETC., SORTED BY HAND ON THIS FLOOR
SACKS DROP TO WESTBOUND TRAINS
SACKING TABLES
INCOMING MAIL DUMPED ON PRIMARY FEED BELT

P. J. Madigan, inventor-mechanic of Chicago post office

"Keep the mail moving" is the central idea around which the entire equipment for handling parcel-post packages in the new Chicago post office is designed, as made clear in diagram


THESE MOTOR TRUCKS BRING FILLED DUMP-TRUCKS FROM WHOLESALE HOUSES
EMPTY
FILLED
PRIMARY FEED BELT CARRIES PACKAGES TO SEPARATION BELTS

Specially designed container trucks on wheels, used for mail receptacles at Chicago business houses, are picked up by motor trucks, unloaded at the post office, hitched together in a train, and drawn by tractor to a feed belt, where they unload their mail without stopping

CHICAGO has practically completed the most marvelous post office in the world—a post office built for speed, where dozens of ingenious mechanical inventions will keep parcels on the move every minute of the day, from the time they enter the building until they are loaded on trains for their destinations.

Machines that Spell Speed

More than four miles of belt conveyors that will handle 10,000 sacks of parcel post every hour; ingenious mobile hand trucks that can be loaded with mail at business houses, hauled to the post office on motor trucks, coupled into miniature freight trains and dumped with lightning speed; amazing sorting belts, chutes, and overhead carrier systems—these are just a few of the working parts that will make up one immense post office unit of half a million square feet capacity. Running with machine-like precision, making use of every square inch of its capacity, substituting machinery for sorting and tossing by hand, Uncle Sam's new mail clearing house in Chicago is expected to establish a world's speed record of more than 800 tons of parcel post a day!

And not the least of the marvels of this gigantic postal machine is the fact that it was conceived and designed, almost in its entirety, in the mind of a single man, P. J. Madigan, of the Chicago postal service—a man of unusual mechanical skill, whose chosen work has been the improvement of methods of handling mails, who tinkered with old half efficient machines, stuck to his job, and finally won distinction and success. Nearly every inch of the Chicago post office is the product of his study and experiment, as are a score of new machines.

When Madigan joined the Chicago postal service in 1894, nearly all the work was performed by hand. Cancelling machines were the only machines in general use. Since then, gearless cancelling machines, improved carriers for pneumatic tube systems, belt conveyor facing tables, an overhead system for handling primary mail, and a score of other time and labor saving improvements have been added; and a large proportion of them have originated in Madigan's brain.

His inventions were installed first in the Quincy Street station, Chicago, where he was in charge. There they proved so successful that they were adopted on a larger scale in the new post office.

Every unit for handling parcel post was designed to keep parcels on the move. And in accomplishing this, the simple little hand truck container already mentioned, is perhaps the most effective of all. Mounted on casters and equipped with a tilting device that permits the top of the truck to swing forward toward

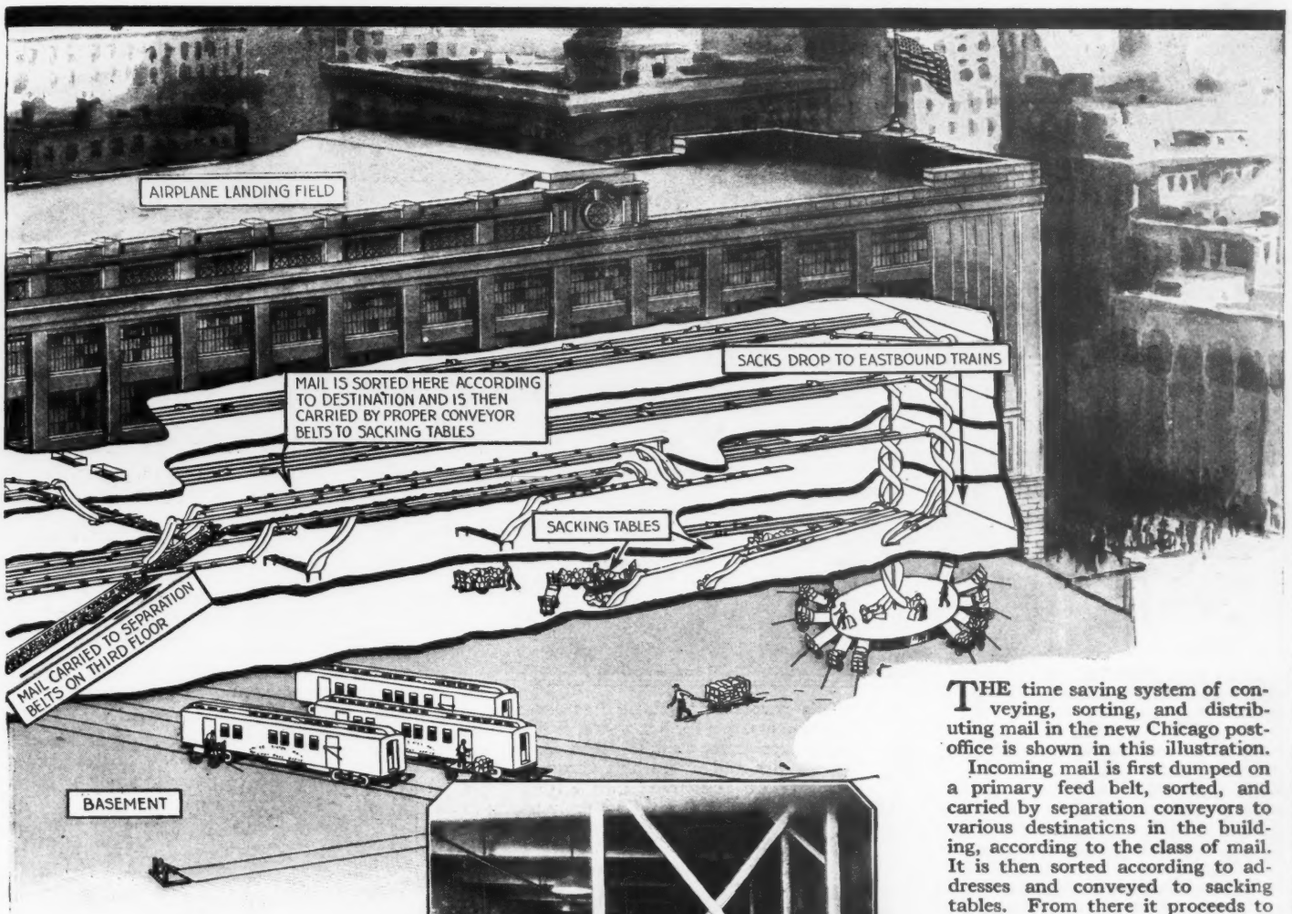
Why Some of Your Letters Go Astray

STATISTICS gathered by the Chicago post office department show that last year one out of every 150 packages received went astray because of incorrect address.

Of 2,266,243,054 pieces of mail, statistics show that: *6,788,000 were returned to the sender; 1,021,300 were corrected and forwarded; 4,370,500 were held for postage; 97,800 bore no address of any kind; and 2,905,000 had to be disposed of as waste.*

This made a total of 15,182,600 pieces of mail incompletely or wrongly addressed or wrapped.

Keep the Mail Moving in New Chicago Post Office


AIRPLANE LANDING FIELD
MAIL IS SORTED HERE ACCORDING TO DESTINATION AND IS THEN CARRIED BY PROPER CONVEYOR BELTS TO SACKING TABLES
SACKS DROP TO EASTBOUND TRAINS
SACKING TABLES
MAIL CARRIED TO SEPARATION BELTS ON THIRD FLOOR
BASEMENT

THE time saving system of conveying, sorting, and distributing mail in the new Chicago post-office is shown in this illustration. Incoming mail is first dumped on a primary feed belt, sorted, and carried by separation conveyors to various destinations in the building, according to the class of mail. It is then sorted according to addresses and conveyed to sacking tables. From there it proceeds to chutes, dropping to outgoing trains

the operator and the bottom to open, this truck entirely eliminates the time-consuming sacking of parcels.

Nearly 80 per cent of loose packages received at the post office comes from business houses. By the new system seven or eight loaded truck-containers can be picked up by one motor truck and driven to the post office. There they are rolled off the truck and eight or ten of them are coupled together, forming a train. A baby tractor then comes along, hooks onto the miniature train, and pulls it past a trough into which the packages are dumped from the trucks by a special device.

Forty men stand at the terminal of each feed belt and sort mail in the Chicago post office, as shown in upper photograph. Sacking at the bottom of the delivery chutes is made easier by the racks shown in lower view

Along the trough a feed belt moves in the opposite direction to that taken by the train, making it possible to unload moving containers without clogging the conveyor or stopping the train. As soon as the containers have been emptied, they are loaded back on motor trucks and returned to business houses. By this system one motor truck arrives, unloads, and reloads with empty containers in just seven minutes.

Once on the feed belt, the parcel travel to "separation units," or distribution points, on the third floor, where they are sorted. Belts moving from these separation units carry the parcel to their various destinations, all uncancelled mail being carried back to the first floor, where it is cancelled and delivered by another belt to the feed belt on the first floor.

All separation belts on the third floor except that which handles uncancelled mail, deliver to spiral chutes leading to the second floor, where parcels are sacked and dropped through openings in the floor to ceiling belts that deliver through chutes to the train level. During the process of sorting, 40 men can stand at the terminal of each feed belt.

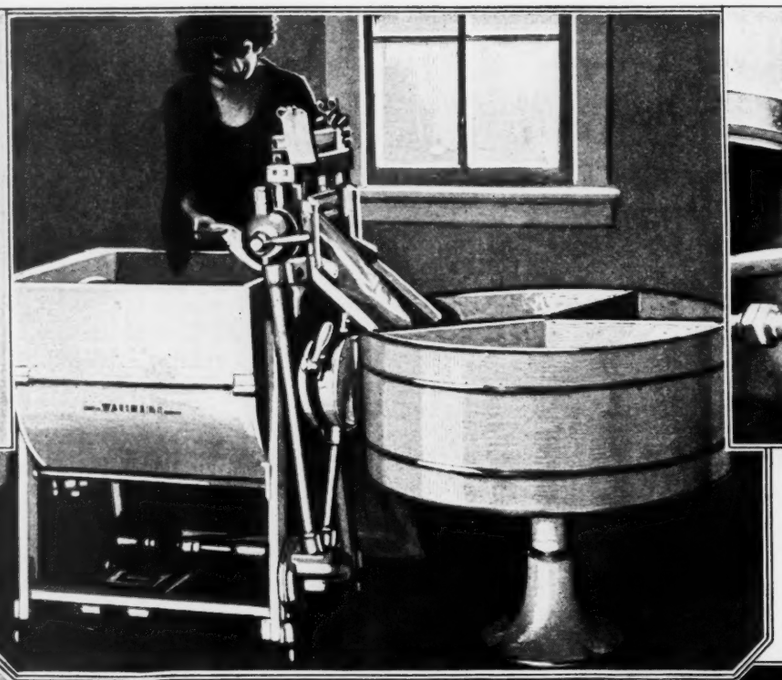
Mail Congestion Is Prevented

The saving of time effected by Madigan overhead conveyor system is shown by the fact that under the old method letters posted in the early afternoon and dumped on the facing table might be buried by later batch of mail dumped on top of them before they could reach the cancelling machine. The overhead system of handling completely eliminates such delays.

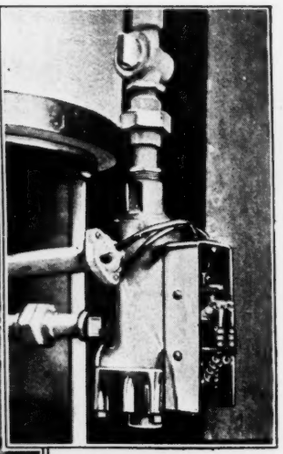
An idea of the expected capacity of the new post office may be gained from the fact that its equipment is expected to double the speed record of the equipment installed by Madigan in the Quincy Street station which last year handled 422 tons of parcel post in one day.

Three-in-One Washtub—New Household Inventions

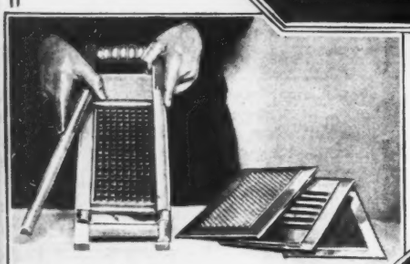
Tying this new mop head over a kitchen broom provides a mop for floor or wall dusting, and is very useful for dusting high moldings



This revolving washtub has three compartments, one for hot water, one for cold, and another for starch. Each section has a stopper and waste hole through which liquids are discharged into a funnel and hose leading to sink. Especially useful in conjunction with an electric washer

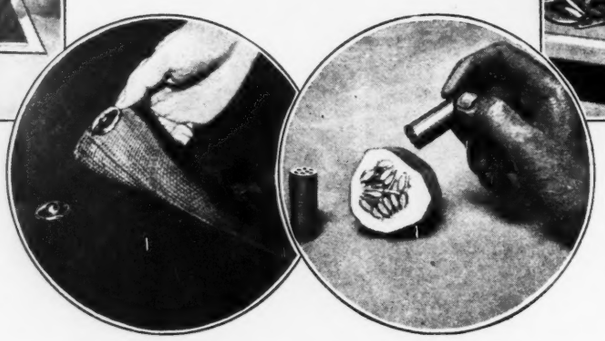


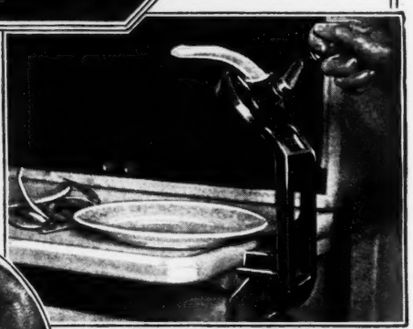
This three-by-eight-inch detachable automatic electric tank heater is equipped with a thermostatic switch that keeps temperature constant and saves current



Every kind of grater comes with this adjustable frame, one side of which slips out to insert new grater

Slipping rugs and upturned edges are prevented by the anti-skid catch, at the right, which buttons the rug to the floor





Beans are stripped of their strings by the turning of a crank on this mechanical bean stringer

Small and inexpensive salt and pepper shakers made of paper (at left) solve a lunch problem for picnickers

Cheaper Print Paper Made from Weedlike Water Plants

THROUGH the invention of a process for the production of cellulose in commercial quantities from reeds, rushes, and other weed-like water plants that clog lakes, rivers and swamps, German scientists claim to have solved the print paper problem, providing a comparatively cheap substitute for the world's diminishing supply of wood pulp.

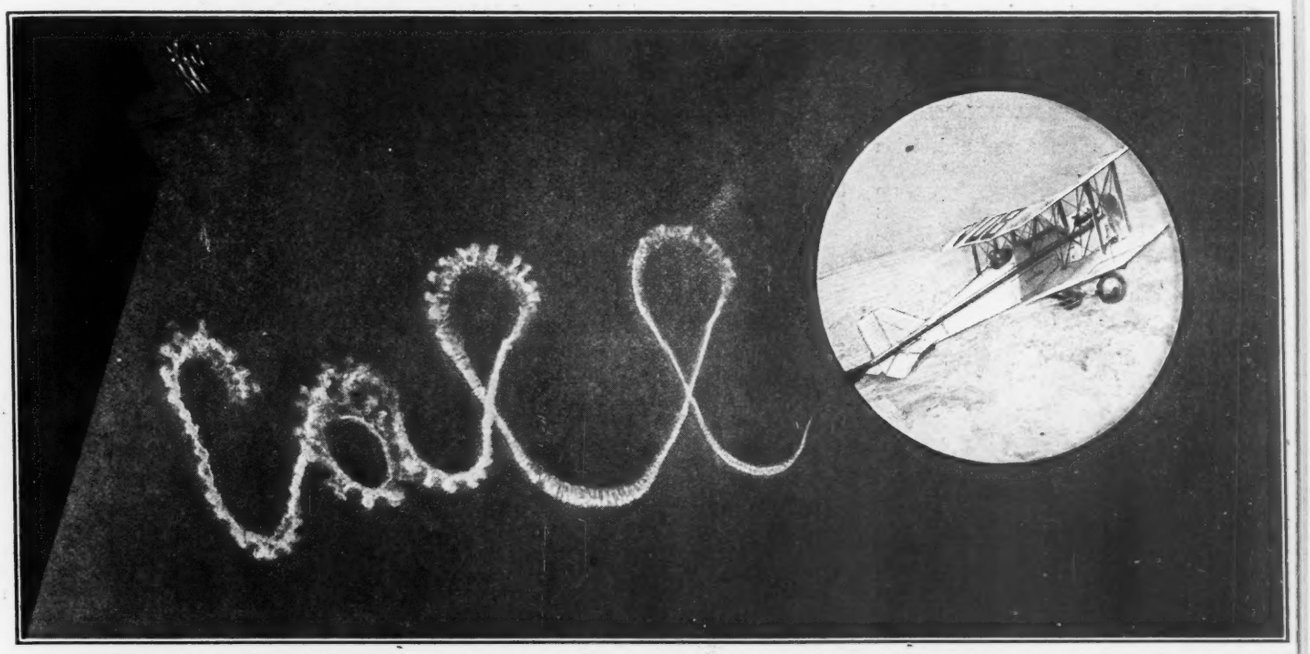
The most common plants used in making the cellulose from which paper is manufactured are reeds, rushes, flax stems, savannah grass, sugar cane, jute, and bamboo. It is said that almost any kind of grain stems can be used also. New crops are available at all seasons of the year in various parts of the world.

A mower mounted on a small flat boat cuts and harvests reeds and rushes from streams for use in manufacturing print paper

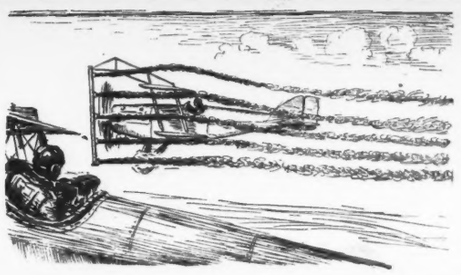
The actual manufacture of the paper, according to reports, requires only two hours and is far cheaper than the wood pulp process. In fact, it is claimed that the price of the new paper will be 60 per cent less than the present price of pulpwood paper.

Cardboard also is produced by the new process. Indeed, despatches from Berlin say that already more than 50,000 inner soles for shoes have been manufactured from reeds and rushes.

Sky Writing to Tell New Facts about Airplanes



The word "Call" written across the sky above New York in smoke letters half a mile high by an airplane piloted by Capt. Cyril Turner



At left—How the inventor of smoke writing proposes to use his invention to study new airplane designs by photographing ribbons of smoke

GIGANTIC words of smoke written across the sky by an airplane in letters half a mile high recently startled New York. The new method of advertising was invented and perfected by Capt. Jack Savage in England.

The words are written by maneuvering a plane carrying special smoke generators that discharge smoke produced at the rate of 1,000,000 cubic feet a second by chemicals that react on each other without producing combustion. When written at a height of 10,000 feet, the letters are visible over an area of 100 square miles for a period of from 20 minutes to an hour.

Sky writing, of course, has tremendous advantages in advertising because of the fact that an ad that may be seen by 1,000,000 people (if made above New York) may be produced for $200.

Captain Savage also sees in the scheme a method for studying air currents and the efficiency of planes. For this he proposes smoke generators located in the forward part of a plane. The downwash, slipstream, and eddies of air around the wings and projecting parts of a plane may be studied by photographing from another plane the ribbons of smoke enveloping the machine being tested.

Captain Savage is now investigating a plan for sky writing at night, using luminous smoke.

"Burbank of Strawberries" Pays $50,000 for New Variety

WOULD you pay $50,000 for the right to propagate a single strawberry?

That is what Frank E. Beatty, president of a Three Rivers, Mich., fruit growing concern, did recently. And yet, the buyer does not consider the price he paid too great. In fact, he is willing to risk his reputation on the statement that "the plant will revolutionize the strawberry industry."

Beatty, an expert in strawberry culture, has been unusually successful with four varieties of the plant. He claims that the $50,000 strawberry plant, which will be known as the "Rockhill," in honor of its originator, Conrad Rockhill—

Produces more, larger, and better berries in early summer than any of the varieties now being grown.

Continues its heavy fruiting during fall months until snow flies.

Produces berries of firm texture, which will withstand long shipments.

Surpasses all other varieties, irrespective of climatic conditions, in productiveness and quality of berries.

Beatty further claims that the plants root deeply, grow luxuriant, tough leaves free from plant diseases, and possess surprising vitality that enables them to produce abundantly.

For the right to propagate the immense strawberry plant above, Frank Beatty, the "Burbank of Strawberries" (at right) paid $50,000

According to the Department of Agriculture, the strawberry is the most valuable of all our small fruits, covering three fourths of the total fruit raising area in the United States. From a commercial standpoint, the chief value of the Beatty plant lies in the durability of the berries after they are picked. For the price of strawberries on the market is largely governed by the fact that so many spoil while being transported to market.

The garden berry is an American product, the result of a cross between the "pine" strawberry of Europe and the American wild strawberry, produced by Hovey, "father of the American strawberry."

Mechanical "White Wings" Guard City Health

Replacing the familiar "White Wing," motor driven sweepers like those shown below are cleaning city streets of refuse and disease breeding dust

ONE of the most pressing problems of modern municipal administration is keeping the streets of our great cities clean," says Commissioner A. R. Taylor, of the New York Street Cleaning Department.

"The tremendous increase of pedestrian and motor traffic makes it increasingly difficult to keep our highways free from germ-laden dust which not only spreads disease, but destroys our clothing, buildings, and merchandise. In New York City 1280 miles of paved area is cleaned daily, 4700 cubic yards of dirt collected, and 3,000,000 gallons of water used to flush the streets."

Street Vacuum Sweepers

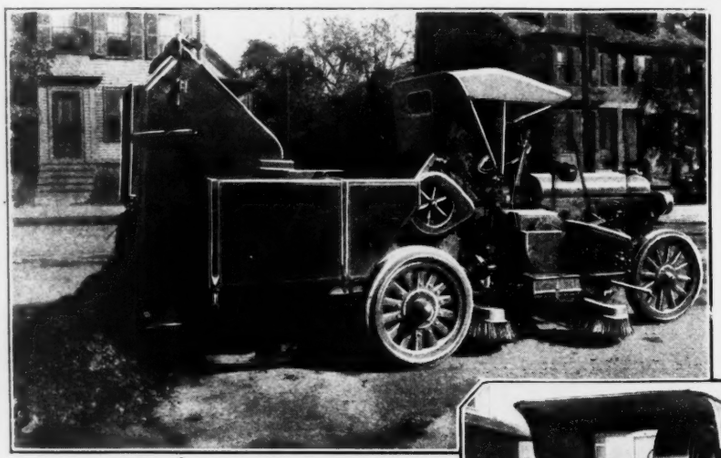
The day of the familiar "white wing" is passing, for hand methods no longer can cope with the mountains of dirt and dust deposited by the increasing horde of autos. Other cities, both abroad and in this country, are meeting the problem with cleverly designed motor driven vacuum street sweepers.

These vacuum sweepers not only pick up dust and dirt from the street, spraying at the same time, but also have attachments for cleaning gutters, into which much of the refuse necessarily is swept.

One ingenious machine, the product of a Sandusky, Ohio, firm, operates like a vacuum carpet sweeper. A huge rotary broom in front throws the dust which has been sprayed into the field of vacuum suction. In St. Louis, within a period of 12 months, or 232 nights of sweeping, these vacuum cleaners picked up 3,448,300 pounds of dirt and dust, cleaning an area of 54,843,152 square yards.

Another machine found to be extremely efficient is produced by a Springfield, Ohio, firm. It was designed to eliminate these features objectionable in earlier motor driven sweepers: excessively wide pick-up brooms, requiring excessively wide elevator belts and perishable wooden brushes.

Fine rotary disk steel brushes scrub material into a windrow so that a pick-up broom, 30 feet wide, delivers it to the elevator belt, which carries it to the dumping device in the rear. Steel brushes last longer and sweep cleaner than the wooden brushes formerly used. A spraying machine keeps down dust while the machine is operating and reduces disease caused by flying germs.



Brushes at the side of the machine shown above sweep dirt with a "scrubbing" motion into a windrow, deliver it by broom to an elevator belt and finally to a dumping hopper

Operating like vacuum carpet sweepers, the machines at right suck up dirt and blow it into trailer vans

Ancient Planting Machine Used in India

THREE hollow bamboo poles fastened in an upright position to the front edge of a thick plank so that their ends come just in front of three wooden harrow teeth, are the essential features of a semi-automatic seeding machine invented centuries ago by the natives of India, and still used by the farmers of the South Deccan.

The bamboo poles act as pipes, and at the upper end all pass through the bottom of a small wooden bowl that holds about a quart of grain. An abundance of cheap handmade rope is wound around the structure to give strength.

One man drives the team of bullocks that pull the seeder over the plowed field, and a second man operates the contrivance. The sower fills his loin girdle with grain, and stands upon the plank. As the team gets under way, he puts small handfuls of grain into the bowl. The seed falls through the poles to the ground, where it is covered with earth by a harrow fastened underneath the plank.

Seeds fed into a small bowl drop through bamboo tubes to the ground and are covered with earth by harrow teeth

Nozzle for Auto Washing Fits Palm of Hand

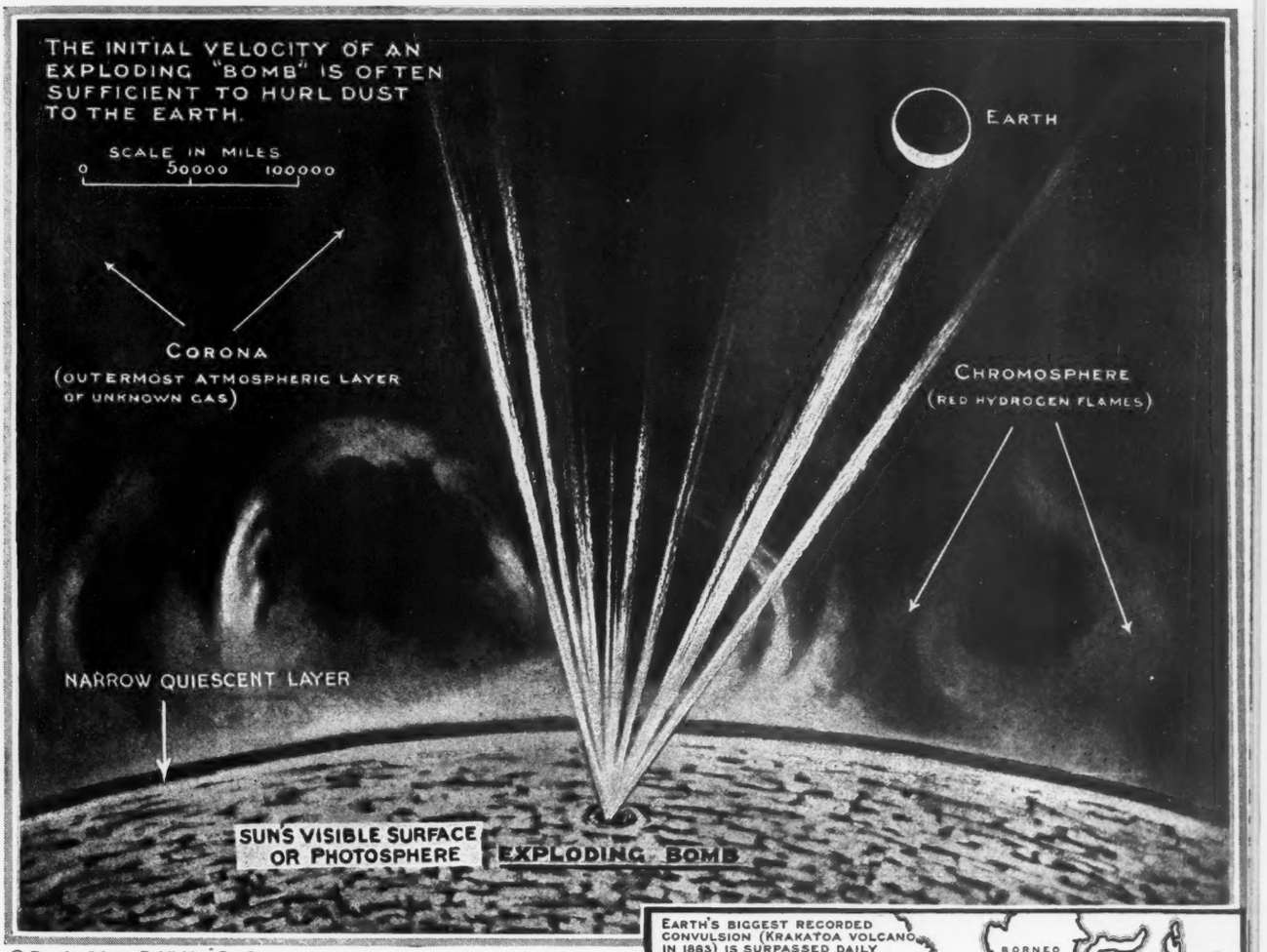
AMONG the novelties in garage accessories is an aluminum nozzle small enough to fit in the palm of a person's hand, and which may be used for washing automobiles. It is screwed to the end of a hose attached to a hydrant faucet and emits a fine but powerful spray for rinsing purposes.

When used with a sponge, the nozzle does not send out a spray, but allows a copious supply of water to percolate through the pores of the sponge, keeping constantly wet while it is in use.

Pressure on grip turns on water

In using the washer, the nozzle is held in the right hand, with the fingers over a curved bar. Pressure on the bar turns on the water, and releasing the pressure shuts it off. If a sponge is used, it is held over the spray with the fingers of the hand holding the nozzle, while the other hand guides the hose.

Does Dust Shot from Sun Cause Storms on Earth?



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This diagram shows present scientific knowledge about the sun. From the sun's surface exploding bombs of incandescent vapor, exerting a force 50,000 times as great as that of the world's most terrific volcanic eruption (Krakatoa, 1883) bombard us with dust clouds

By Scriven Bolton, F.R.A.S.

IS THE earth being bombarded continually by explosions of huge solar "bombs," shot from the sun's surface? Science believes that it is and that the air we breathe often becomes abnormally charged with this "bomb" dust, causing unnatural vagaries of the weather such as rain and electrical storms.

These solar explosions, powerful enough to hurl electrically charged dust particles 93,000,000 miles to our earth, are 50,000 times as tremendous as the greatest terrestrial convulsions ever known. Shot forth like great Roman candles from the sun's fiery interior, the bombs are often 1000 miles in diameter and are composed of incandescent hydrogen estimated to have even a higher temperature than that of the sun's surface—15,000° Fahrenheit.

50,000 Volcanoes in One Bomb

Just how terrific the explosions are may be imagined from the fact that the greatest terrestrial convulsion on record—the eruption of the volcano Krakatoa in Sunda Strait, near the island of Java, August 27, 1883—represented but one fifty thousandth part of the energy believed to be released in a single explosion of a solar bomb. The reverberation from the Krakatoa eruption shook our entire globe, sending measurable ripples of air twice around the earth and hurling fine dust to a height of 80 miles. Yet one solar explosion hurls dust particles millions of miles into space.

On the surface of the sun the force of gravity, irrespective of atmospheric friction, is powerless to check an upward initial velocity exceeding 385 miles a second. Particles exceeding this velocity when hurled upward by a tremendous solar upheaval fly into space, never to return.

These particles, it is believed, form the dust shoals that bombard our earth and other planets. Since the dust is electrically charged, it probably causes phenomena such as severe magnetic storms during which the compass needle is agitated. On rare occasions the surplus electric charge has been known to paralyze telegraph and tramway services. Moreover, some meteorologists firmly believe that clouds and raindrops would not form in our atmosphere without the presence of this dust. It becomes obvious, therefore, that when the earth is passing through a dust shoal, clouds and rain may be more prevalent, and seasons subjected to bewildering vagaries.

Astronomers now are seeking to discover the cause of these strange solar bomb explosions. While they know practically nothing about the heart of the sun, the have learned that this nucleus is su rounded by definite concentric layers, fir by a luminous envelope of vaporous matt called the "photosphere," which we s when we look at the sun; then by a secon layer of glowing gases cooler than the ph tosphere and forming a smoky veil from 5 to 1000 miles thick; thirdly, by a sea of re surging fire, consisting chiefly of flamin hydrogen vapor, and called the "chrom sphere." From this sea great tongues hydrogen and calcium vapor flames a driven outward for thousands of miles some mighty unknown force.

Finally, the outermost region of the s is an atmospheric layer, consisting of u known gas, called the "corona," a silve halo that we can see during an eclipse the sun.

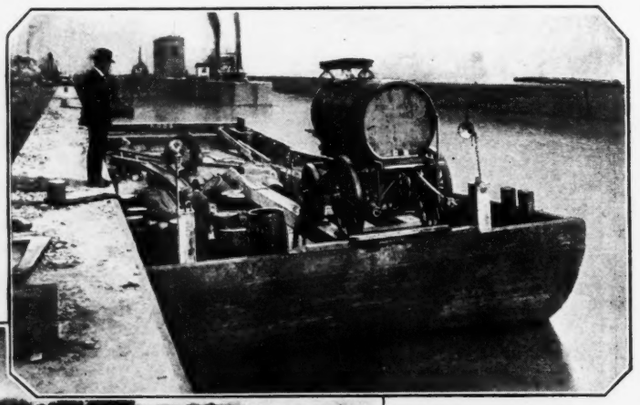
Scientists tell us that much of the light this halo probably is sunlight reflect from particles of dust like those that t mendous solar explosions drive to o earth in clouds.

Fog Dispelled by Oil Film on River Surface

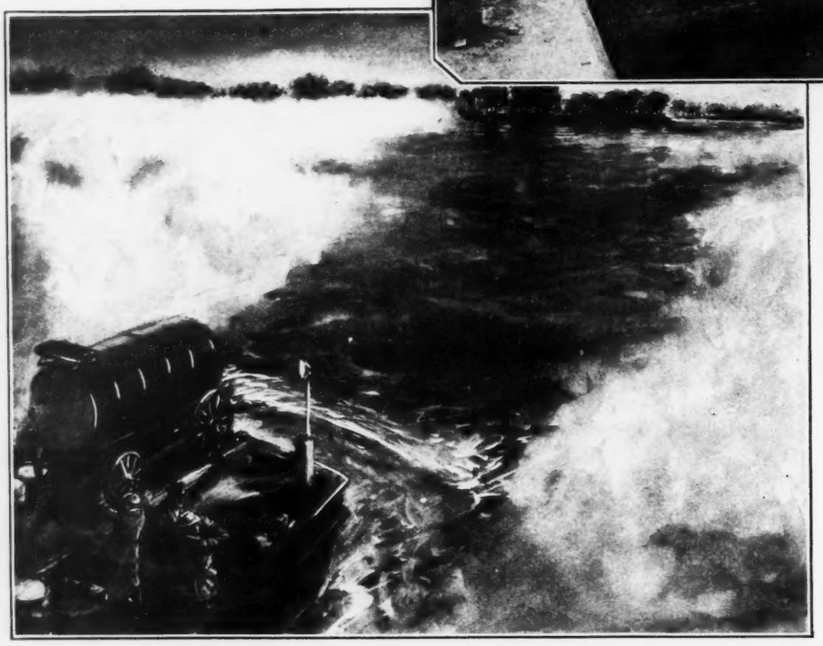
ARMED only with a city sprinkling wagon placed on a government barge, a mixture of oil and organic acid, and data obtained in laboratory experiments, Pittsburgh, Pa., scientists, cooperating with the United States Engineering Department and the Weather Buraeu, recently outwitted nature, proving that fog prevention is possible.

By pouring an oil film over the surface of the Monongahela River from Rices Landing, 35 miles south of Pittsburgh, to a point 1½ miles upstream, the scientists succeeded in cutting a distinct lane through the river mists, demonstrating that any city situated on an inland body of water can rid itself of much of its fog nuisance. In Pittsburgh, where the Monongahela and Allegheny rivers join to form the Ohio, the fog nuisance has been so serious at times as to tie up traffic. By shutting off sunlight, it has menaced the city's health and has cost thousands of dollars in damages and in abnormal consumption of electricity for lighting.

The experimenters aboard the government boat "Evelyn," towing a barge equipped with a crude sprinkling apparatus, began their work at 10 o'clock one evening, after a heavy fog had settled. As the sprinkler began pouring a path of oil in the wake of the barge, a strange phenomenon occurred. Everywhere ahead of the boats was a heavy blanket of mist; but in the rear the fog had been split apart, and the air was clear. This path of clear air widened rapidly as the oil film spread. The phenomenon continued for four hours, when the oil supply gave out.



Spraying the water with a mixture of oil and organic acid from an old sprinkling wagon mounted on a scow (at right), experimenters cleared a path through heavy fog on the Monongahela. Fog remained on each side of the oil film, as shown below



On the following morning, a trip of inspection showed that the oil covered the entire surface, but was too thin in spots to be effective. Yet for the first time in five mornings, government men at Rices Landing could see across the river.

The following facts are significant:

Less than $75 worth of oil and organic acid was consumed.

Scientists estimated that if a proper amount had been available, the oil film would have been effective for about 100 days.

An organic mixture added to the oil made possible a film of one one-thousandth of an inch in thickness—the thinnest film ever created in open air.

The treated oil spreads 25 times as fast as untreated oil.

Speedy New Battle Tanks for Army

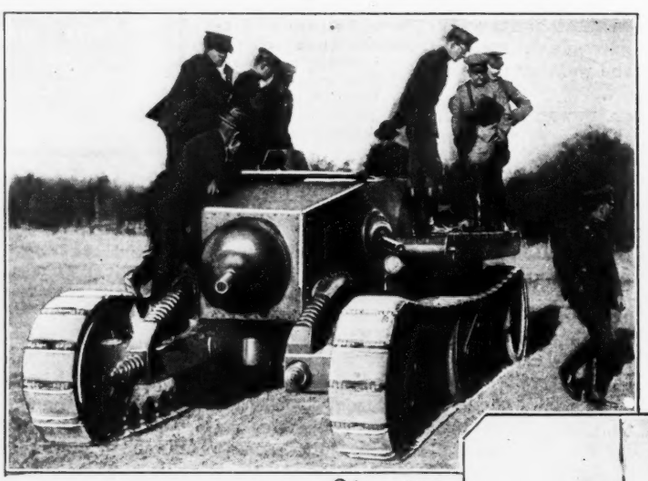
FOLLOWING recent amazing exhibitions by a new amphibious gun carriage tank that "runs like a rabbit, climbs like a squirrel, and swims like an otter," nearly a hundred military authorities of this country pronounced it one of the most revolutionary war machines ever invented. Now a second new development of the war tank, exhibited by the army at Washington, known as a "speedster," attains a speed of 40 miles an hour, and is considered almost shellproof because of the pace it sets.

Tank Crosses the Hudson River

The amphibious tank, carrying a "six pounder" and three machine guns, traveled at a speed of 30 miles an hour down Riverside Drive, New York City, was then converted into a tractor and easily climbed a 45-degree hill, finally completing its performance by accomplishing the astounding feat of propelling itself across the Hudson River and back—1.7 miles each way—in 44 minutes.

Uncle Sam owns the patents on this tank, which is the result of work by Walter Christie, former daredevil auto driver. The tank, 15 feet long, six feet wide, and weighing six tons, has four wheels on each side that run on a track laid down by the endless tread. When operating with the endless tread removed, the machine attains a speed of from 30 to 40 miles an hour. In the water, the tank is driven by detachable propeller blades.

The new speedster tank is equipped for long runs, carries a 75-millimeter field gun, can accommodate 10 men and supplies and ammunition sufficient to last 10 days.



© International

The army's new "speedster" tank, shown at left, is equipped for long distance runs and can attain a speed of 40 miles an hour. Below: The Christie amphibious tank is shown starting to climb a 45-degree hill in a recent amazing exhibition in New York City, afterward propelling itself across the Hudson like a boat

Sugar Syrup Prevents Frozen Radiators

TO PREVENT automobile radiators from freezing, glucose—or sugar syrup—has been recommended by Dr. Charles H. La Wall, of the Philadelphia College of Pharmacy and Science, as a substitute for anti-freezing compounds containing denatured or wood alcohol.

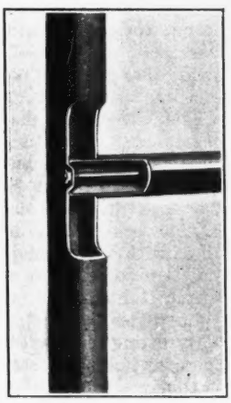
Because glucose does not evaporate, Doctor Wall declares it is far superior to other mixtures. Using about a pint and a half of ordinary confectioners' glucose to a gallon of water, he finds that the mixture starts to become slushy at a temperature of about 10 degrees above zero, but that it does not actually freeze and harden even at six degrees below zero.

The mixture does not corrode metal parts, he says, nor does it affect rubber.

Ladder of Steel Tubing Is Light and Durable

STEEL tubing is being used by a Detroit concern in the manufacture of ladders, which, it is claimed, are lighter and stronger than wooden ladders.

Oval tubing of specially tempered steel used for the side members is drilled to take round tubular rungs. Threaded tie bolts through the centers of the rungs hold the ladder together.



How rung is joined to side members

Flexible Plow Is Unit with Tractor

BY AN ingenious method of attachment, a new type of tractor plow recently introduced into the United States by Harry Ferguson, of Belfast, Ireland, becomes a unit with the machine that hauls it. Only slight exertion on the part of the operator is required to raise the bottoms of the plow from the ground. When raised, the plow is suspended in the air, so that the tractor may be driven over rough country, backed up, or maneuvered in any desired way.

One of the unusual features is that the tractor power is conveyed to the plowshares through an inverted V-shaped arrangement of steel bars. Should the plow strike a rock or any other obstruction, the pull tends to straighten out this V and the bearing is so shifted that the rear of the tractor is raised from the ground. This allows the tractor wheels to spin and thereby prevents th plow from breaking.

The depth to which the plows penetrat is regulated by a single wheel attached o one side and the tilt of the shares is adjuste by a handle. The entire plow mechanis may be raised by depressing a lever.

Photo courtesy of *Farm Mechanics*

Forming a unit with the tractor, the plow may be raised or lowered as shown at left. If the plow strikes an obstruction, as above, the rear of the tractor is raised automatically so that the wheels spin and the plow is not broken

This Rudder Steers or Propels Rowboat

A NOVEL rowboat rudder that may be used either for steering or for propulsion has a rudder board cut in the form of a U. When the rudder is to be used for steering only, this opening is closed with an oval flap hinged to the arms of the U. When this flap is swung free, it trails in the wake of the rudder.

If the rudder is to be used for sculling, one end of the crossbar of the rudder post is connected by an iron rod with a lever that is moved forward and backward like a pump handle. This causes the rudder with its swinging flap to oscillate horizontally like the tail of a fish, and imparts to the boat a forward motion of fair speed, not as great, however, as that imparted to it by the more strenuous use of a pair of vigorously pulled oars.

Operated by a lever, as shown above, the swinging flap of this rudder oscillates like a fish's tail to propel the boat

Sings as She Writes Three Words at Once

BY WRITING three words at one tim and accompanying this feat with a son a young German woman, Thea Alba, r cently exhibited her remarkable ability t conduct simultaneously four separate no related actions.

Many of us who have tried to write figure eight on the wall while describing circle with one foot will appreciate the ski required for such performance. It was he ability to execute this exercise that mad her aware of her unusual powers. Phys cians who became interested in her ex hibitions decided to study her actions t determine whether her feats were accom plished by separate yet simultaneou thoughts or by an unusual ability to tran fer her thoughts quickly.

If these questions are answered, Germa psychologists believe they will be able t tell us more definitely about our menta processes.

Young Scientist Explains Why Stucco Houses Crack

BY DELVING into a field hitherto little explored by scientists, Ben H. Peterson, recently graduated student in chemistry at Coe College, Cedar Rapids, Ia., has succeeded in explaining some of the reasons why many stucco homes crack and otherwise deteriorate sooner than they should. His discoveries may serve as a foundation for other experiments that should prove valuable to builders of stucco homes in the future.

Peterson, who did this work preliminary to writing his thesis for graduation, had no references to guide him. He constructed his own testing apparatus, and worked out his own formulae. Two of the devices he used—a machine for measuring the cross-breaking strength of a bar of stucco and a delicate device that measures expansion under various degrees of heat and cold to the millionth of an inch—are so ingenious that he has been advised to have them patented.

During his experiments, the student tested more than 6000 stucco bars of varying compositions and ran more than 2000 analyses. He tested tensile or "stretching" strength, the cross-breaking strength (by which he determined capacity to bear weight), expansion, solubility, and a number of other qualities of the building material. Variation in stucco material, he found, is due chiefly to lime content.

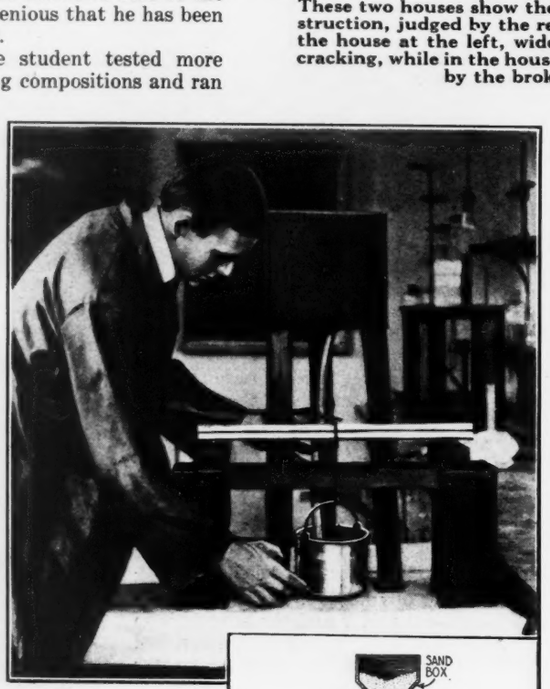
These two houses show the wrong and the right way of stucco construction, judged by the results of Ben Peterson's experiments. In the house at the left, wide, unbroken expanses of stucco result in cracking, while in the house at the right such expanses are prevented by the broken architectural design

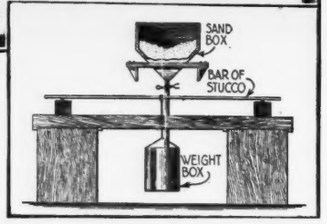
The Effects of Rain

One of Peterson's chief tests proved how much weight a bar of stucco loses by exposure to water. He found that about five per cent of the weight of a stucco bar was lost after the bar was immersed in water for 120 hours. From this he computed how long a stucco building could withstand dissolving by rain and snow.

In general, Peterson's tests tended to show that the cracking of stucco on a house is due not to composition, within certain limits of lime content, but to shrinkage during setting and to the fact that the stresses on wide expanses of the material are not properly taken into consideration when the house is built. He found, however, that an extremely high lime content causes abnormal shrinkage.

His practical recommendation to architects is that they should panel strips of stucco more than six feet wide, thus relieving the strain caused by varying temperatures, weight, and solubility to rain. Paneling also will facilitate repair, he says. Unbroken strips of stucco all the way across a 30 or 40 foot house, he found, are subjected to fearful strains, even in ordinary ranges of temperature, and are apt to crack.





BEN PETERSON, the young student whose experiments have revealed important new facts about stucco construction, is shown above working on the apparatus (described in diagram) with which he tested the cross-breaking strength of a bar of stucco.

Resting the bar on supported rollers, he applied a weight box, connected with a sand box, to the middle of the bar. A stopcock shut off the flow of sand at the breaking point of the bar

How Stucco Compares with Frame and Brick

ALTHOUGH it is impossible to give positive comparisons as to the relative cost and durability of brick, frame, and stucco houses, architects generally estimate that on a basis of 20 cents a cubic foot for frame houses, brick houses of the same class cost 22 cents, and stucco approximately 21 cents a cubic foot. In durability, brick construction is rated first; stucco second, and frame third.

As to the relative advantages of each, the frame buildings are attractive, easiest to build, and lowest in first cost, but are greatly exposed to fire risks and require much upkeep. Stucco homes are considered extremely attractive, are warm in winter and cool in summer, and their first cost, as well as upkeep cost, is low. Brick homes cost most, but, as with the stucco house, again the cost of upkeep is extremely low, though they lack somewhat the variety possible with stucco houses of the same price.

Small Powered Bench Saw for the Metal Shop

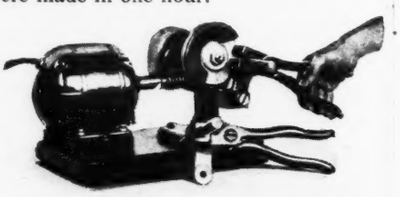
SPEED of production in a shop or factory in which metal rods or pipes must be cut to size in large quantities is being increased by the use of a new and extremely handy power driven bench saw that weighs, with motor, only 40 pounds.

The new saw, driven by one-eighth-horsepower motor, is one-thirty-second of an inch thick and has a diameter of 3½ inches. Due to the thinness of the blade, there is little waste of stock in cutting.

The work-holding device has the form of pliers with V-shaped jaws, like a pipe vise, and is pivoted to an arm of the saw support. It holds the stock to be sawed at right angles to the plane of the saw.

By lifting the handles of the holder, the operator holds the stock against the teeth of the saw. A stop gage is provided for adjusting the length of the part to be cut off from the stock.

The efficiency of this saw may be judged from some test results. It cut through a one-half-inch round, cold-rolled steel rod in 40 seconds. Through five-eighths-inch brass rod 250 cuts; through three-sixteenth-inch brass rod 1800 cuts; and through five-eighth-inch round hard rubber 1200 cuts were made in one hour.



The new bench saw, showing plier-like device for holding the work

Burbank's Own Life Story

CALIFORNIA this month celebrates the fiftieth anniversary of Luther Burbank's wizardry in creating new flowers, fruits and vegetables. This grand old man of plant breeding is one of America's most picturesque and fascinating figures. All his past achievements are dwarfed by the fact that at the age of 74 he has come to cherish the dream of raising a better race of humans according to laws he has discovered in plant raising.

Burbank writes of his work and his dream in an article that every American should read in the April number.

Tree-Destroying Moss Used to Stuff Mattresses

AN INDUSTRY from which the South, especially Louisiana, derives an income of $3,000,000 annualiy has been developed by the commercialization of methods of converting the picturesque but tree-destroying "Spanish moss" into a cheap substitute for horsehair for use in mattresses and upholstery.

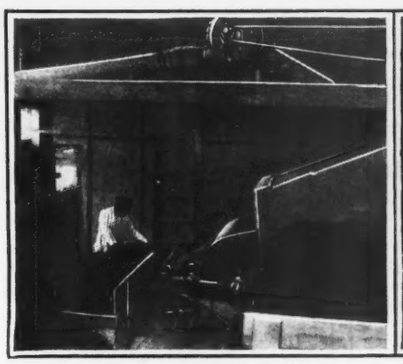
Spanish moss is the name given by Spanish settlers to an epiphyte or "air plant," gray in color, which hangs from the tree branches in the South, looking like enormous beards. Although like an ordinary parasite in that it grows over the tree, it does not derive its nutrition from the tree, but from the air.

The best Spanish moss grows to a length of four or five feet. Most of it is gathered after cypress trees are felled for the sawmills.

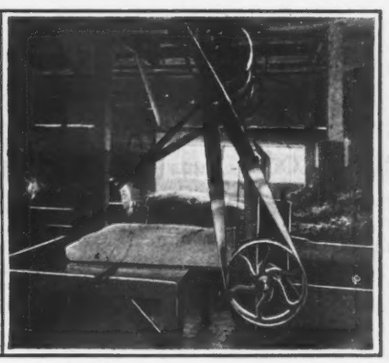
In the bayou districts, moss gatherers float under trees in flat boats and drag the air plants down with long poles. Then they carry the moss in bundles to their homes, where they heap it in big piles, sprinkling these with water, which causes the outer bark to rot off. After it has been thus cured, the moss is sent to a ginnery, where it is run through a set of double rollers equipped with teeth, a fan blower, and a baler. The rollers crush the sticks, teeth comb out the moss, while blowers dry the moss and blow away the trash.

Each year Louisiana ships from 2000 to 5000 carloads of ginned moss, which brings from six to 11 cents a pound.

Above, Spanish moss hanging like gray beards from an avenue of oak trees in Louisiana. Left, gatherer returning with his day's "catch" of moss



Moss gin, where "vegetable hair" is combed, freed from impurities, and dried



Machine stuffing mattresses with ginned Spanish moss used as horsehair substitute

Mechanical Arms Pick Up and Elevate Boxes in Tiers

ARRANGEMENT of boxes and other materials in tiers has proved such an expense to factories that engineers, casting about for a means of doing this work mechanically, have succeeded in designing a small electric storage battery tiering truck equipped with sets of arms that imitate human arms.

The attachment consists of two sets of arms and an elevating mechanism, located on the front of an electric truck. In using the longer set of arms to pick up square boxes, it is necessary to have the material raised a few inches above the floor. The operator lowers the two arms and inserts them under the pile by moving the truck forward. Power is applied to the elevator screws and the load is raised from the floor. The truck is then run to the tier and the material raised to any elevation up to six feet, and deposited.

Mechanical arms grasping cylindrical container

The second set of arms pick up round or flat packages by holding on to handles. When changing from one set of arms to the other, the operator simply moves a lever and the two sets automatically change position. This is done by gear quadrants connecting the two sets.

Fertilizer from Straw

A PROCESS for the artificial production of effective fertilizer from straw has been patented in England.

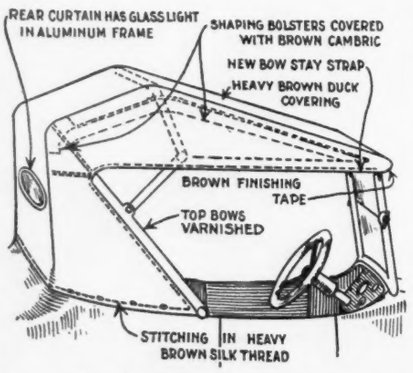
Straw is subjected to the action of a culture of cellulose-destroying organisms with the addition of certain chemicals to start the reaction. The finished product contains about two per cent of nitrogen. Any farmer, it is claimed, can turn his entire straw crop into about half its weight of nitrogen-bearing fertilizer.

Re-Covering Your Auto Top Cheaply

By G. A. Luers

A MOTORIST, who had painted his roadster dark blue and had given it a high luster with coach varnish, found that the old mohair top looked shabbier than ever by contrast. He decided to re-cover the top himself and found the work not as difficult as he had imagined.

He measured the amount of material required and bought sufficient heavy, closely woven brown duck for the new top, as well as binding tape of the same color, some brown cambric for the shabby bolsters, an oval rear light glass with an aluminum frame, round head upholstery tacks, and a little oak coach varnish.


REAR CURTAIN HAS GLASS LIGHT IN ALUMINUM FRAME
SHAPING BOLSTERS COVERED WITH BROWN CAMBRIC
NEW BOW STAY STRAP
HEAVY BROWN DUCK COVERING
BROWN FINISHING TAPE
TOP BOWS VARNISHED
STITCHING IN HEAVY BROWN SILK THREAD

The old top serves as a pattern for cutting a new cover

As he removed the top with a tack puller and pliers, he noted how each piece was fastened. He then refinished the top bows with varnish, cut new stay straps from brown duck, and made them fast to the bows. The bolstering was covered with cambric and fastened in place.

Using the old top as a pattern, he next cut the brown duck to the exact shape and sewed the pieces together on the sewing machine with heavy brown silk. The rear light was set in the back section and then the new cover was spread over and tacked to the frame while the frame was held in position with bindings of heavy twine. The finishing tape was put on and the top then matched in newness the appearance of the newly painted and varnished car itself.

No special tools are required and nothing about the work is difficult, although care must be taken to cut the materials the exact pattern of the parts removed and in alining the top bows properly before putting on the new covering.

It is necessary to use a tape line frequently to make sure that pieces on opposite sides are uniform and that the rear curtain is located so that the light is in a central position. A new top usually increases a car's selling value far more than the cost of labor and materials involved.

Rotary Brush Removes Carbon Dust from Auto Engine

OFTEN the tops of pistons and the walls of the combustion chamber in an automobile motor are not thoroughly cleaned of fine carbon dust after they have apparently been scraped clean. The removal of this dust can be accomplished with a wire brush and a small hand drill.

Cut off the brush handle, drill a hole exactly in the center, thread in a wood screw, and cut off the head of the screw. This provides a metal shank that can be held in the hand drill chuck. With this rotary brush the tops of the pistons and the walls of the combustion chamber can be polished, which insures better engine performance and tends to prevent the carbon forming quickly again.—R. FRANKLIN MUNDORFF, Kansas City, Mo.

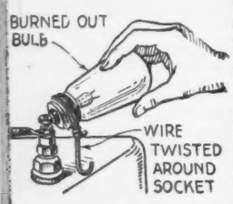
Wooden Blocks for Garage Floor

A NEIGHBOR who recently put in a portable garage and was particularly anxious to have it comfortable, made a floor of wooden paving blocks obtained at a nominal cost from the surplus stock of a street paving company.

The earth was leveled and the blocks laid in even rows. Since the blocks were creosoted, no precautions were necessary to prevent decay. In case it becomes necessary to move the garage, the floor can be taken up and relaid.—L. D. W.

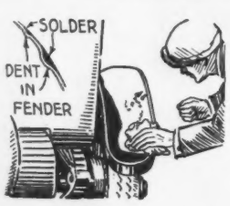
Burned Out Electric Lamp Tests Automobile Spark Plugs

A NOVEL method used by an automobile mechanic to test out spark plugs while the automobile engine is running requires nothing more than a burned out electric light bulb and a piece of wire. The wire is twisted around the socket to form an extension and is touched against the engine head while the central terminal of the lamp is pressed against the spark plug binding post. If the spark is functioning properly, it is visible between the lead-in wires in the globe.



Removing Small Fender Dents

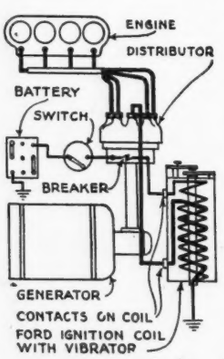
ALMOST every autoist is confronted at some time or other with the task of removing a small dent or dents from the fender of his automobile. This is sometimes a difficult undertaking, but a simple method that usually works well is to clean the dent carefully, fill it with solder, and scrape off the solder flush with the surface of the fender. The solder is then painted to match the rest of the finish.



Such a repair is apt to be more satisfactory in appearance than when straightened with a block and hammer.—F. A. L.

Vibrating Coil Overcomes Bad Ignition

THE addition of a vibrating coil will sometimes remedy serious difficulties in an ordinary battery ignition system. Such a system supplies a single spark and when the ignition, carburization, cylinders, and valves are in first class condition, that is sufficient. When, however, the ignition coil breaks down, the ignition mechanism and the carburetor become worn or are out of adjustment, and the cylinders, valves or valve stem leak, a succession of sparks is apt to improve the running to a marked degree.



How the vibrating coil is connected

An ordinary vibrating coil, such as is used in Fords, is substituted for the regular coil. Therefore, when the breaker points close, a steady stream of sparks passes between the spark plug points. The breaker mechanism is designed to generate a spark at the plug points when the breaker points open, but this device starts a stream of sparks when the breaker points close, previous to opening, and this stream continues as long as the points are closed. Sometimes retiming may be found necessary.

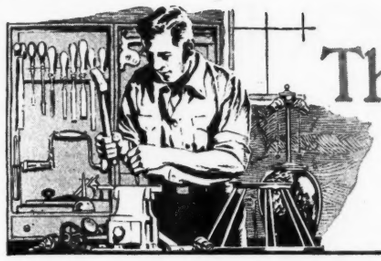
This expedient is particularly effective in improving the running of a faulty engine at low speed because the series of sparks occur when the engine is operating on practically a closed throttle.

The coil is mounted so that the bottom contact is grounded on the frame of the car or the engine and a wire is carried from the lower contact to the top of the distributor. The coil wire of the circuit breaker connects with the upper contact, and the other wiring from circuit breaker to switch and to battery remains unchanged.

Since a vibrating coil costs little, it is possible to try out this device without much expense. Installations that have been used have given such satisfactory results that it may be concluded that a used car fitted with a vibrating coil is given a new life not possible even by entirely renewing its single spark type of ignition system.—A. L. B.

Repairing a Cracked Windshield

TO REPAIR a cracked windshield, first take a piece of sheet steel and bend it to the shape of a channel slightly larger than the thickness of the glass. Next, soak a piece of canvas or similar goods in shellac and lay this over the edge of the glass. Force the channel over the canvas onto the glass.—J. S. MITTAG, JR.



The Home Workshop

New and Useful Things to Make with Tools

Tools for the Home Workshop and Their Care

The Kit I Use for Odd Jobs about the House

By A. E. Elling

IS YOUR home workshop really well equipped to do all the odd jobs about the house that would cost money if you appealed to an outside man? Have you enough tools? Have you the right tools? Do you know how to care for them properly?

Good tools represent a permanent and valuable investment, which can be wasted by lack of care. Too many tool users buy them in a rather haphazard fashion, getting odd tools for odd jobs, one at a time, without building up a well balanced, completely planned set. As a result, they find that the needed tool is not at hand in an emergency.

I have listed below what seems to me the ideal tool set for general house woodworking jobs. If my own tools were lost, these are the ones I should feel it necessary to obtain. Others would be needed for bench work and still others for metal work; I am speaking now only of general household woodwork. The list is, of course, not complete, and yet may be too complete for some; but it will give you an idea of what experienced tool users find essential.

Crosscut saw, 26 in., 8 pts. Ripsaw, 26 in., 5 pts. Compass saw, 12 in. Backsaw, 10 in. Hacksaw frame, 8 in., with blades.
Fore plane, iron with wood bottom. Jack plane, iron or iron with wood bottom. Smooth plane, iron. Block plane, iron. Rabbet plane, iron or wood, 7/8 in. or 1 in.
Chisels—3/8, 3/4, 7/8, and 1 in. Butt chisel (short) 1 1/4 in. Gouge, 5/8 in. Cold chisel, 5/8 in.
Auger bits—3/8, 1/2, 5/8, 3/4, and 7/8 in. Expansive bit with 2 cutters. Gimlet bits or bitstock twist drills, from 1/16 to 1/4 in. Screwdriver bit, 3/8 in. Rose countersink.
Brace, 8-in. sweep
Hammer with bell or slightly rounded face
Screwdriver
Two-foot rule
Marking gage
Trysquare, 6 in.
Oilstone
Oilcan
Combination pliers, 6 in.
Carpenter's pincers, 8 in.
Monkey wrench, 10 in.
Level, light metal or wood
Spokeshave, wood or metal, 2 or 2 1/8 in. cutter
Cabinet scraper and burnisher
Sliding T bevel
Half round wood rasp, 10 in.; flat bastard file, 8 in.
Saw vise, saw set, and slim taper saw files, 5, 6, and 7 in.
Tool grinder
Steel square, 16 by 24 in.
Wing dividers or carpenter's scriber
Nail set, 1/16 in. cupped point

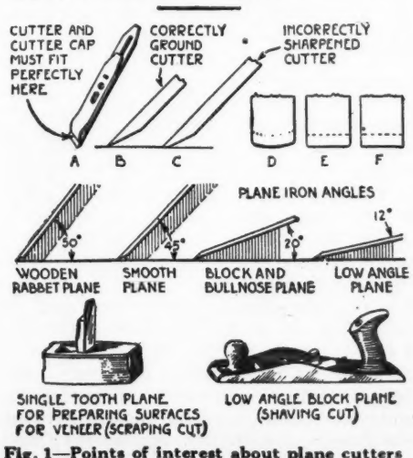
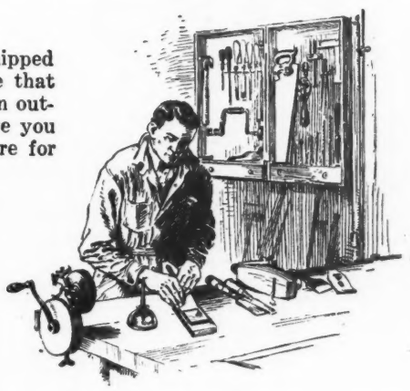


Fig. 1—Points of interest about plane cutters and two extreme types of planes



Three Experts Unlock Their Toolchests for You

LIVING in what might be called a toolmade world, every man finds fascination in the subject of tools and tool craft. In fact, the use of tools in the home workshop has lately become a leading hobby in this country—a hobby that is winning new recruits daily.

"What tools shall I buy?" and "How can I get the most out of my tools?" are two questions repeatedly asked us both by these new tool users and many others who already have the home workshop hobby.

To compress authoritative answers to these questions in the smallest possible space, POPULAR SCIENCE MONTHLY asked three experts to tell just what tools they use in their own home workshops and how they care for them.

Mr. A. E. Elling tells of woodworking tools on this page, Mr. Joe V. Romig discusses the tools he uses for home metal work on page 112 and Mr. George A. Luers writes on "How I Choose Tools for Repairing My Auto," on page 113.

In buying small bits I prefer to get bitstock twist drills that will cut both metal and wood.

As to the care of tools, most common tools are comparatively foolproof if given a reasonable amount of attention. The plane is one of the tricky tools, but when the home worker once learns how to keep his planes, chisels, and saws in good condition, he will not have much trouble.

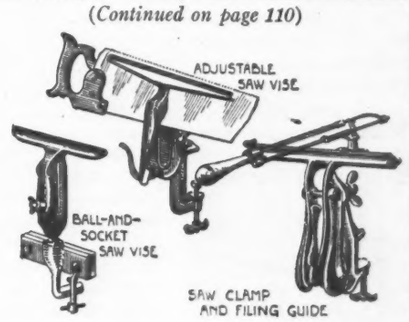
Tools should, of course, be of good quality to start with. I remember a young man learning his trade who was trying out a smooth plane he had just bought. Having no success with it, he appealed to me and I sharpened it and told him to try again, but in a short time it refused to cut. Then I knew the cause was not in the sharpening or setting of the blade, but in the poorly tempered steel. After taking off a few shavings, it fell down on its job.

This is the greatest discouragement that is apt to come to the amateur woodworker—trying to keep in condition a piece of soft steel or, much more rarely, a very hard or brittle blade. Some mechanics profess to be able to judge by looking at it, from its color and general appearance, but personally I have never felt sure of this and I notice that these men, like myself, want the maker's name back of the blade as a guarantee that it is a piece of good steel. If, after sharpening a tool, you find it will not hold its edge a reasonable time on tough wood, exchange it, have it tempered again, or throw it away.

When not properly adjusted, planes sometimes choke or chatter and are not sweet cutting. A careful examination must then be made in both iron and wood planes to see if the back or cap iron fits perfectly tight and snug when screwed to the cutting iron, as at *A*, Fig. 1. Sometimes a very slight opening in one corner will let in a light shaving and that at once chokes the plane. Use an oilstone and a fine file on the back iron to make the two blades fit absolutely tight, so that not the thinnest shaving can get between them.

Again, when the iron is in place, held by a clamp in iron planes, or in a wedge in wooden ones, the blade is sometimes tighter on one side than the other. This may be only a trifle, yet enough to cause trouble. It may be remedied by adjusting the seat or bed of the plane with a file or chisel. It is absolutely necessary that the blade should

(*Continued on page 110*)



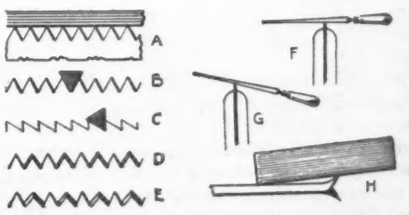


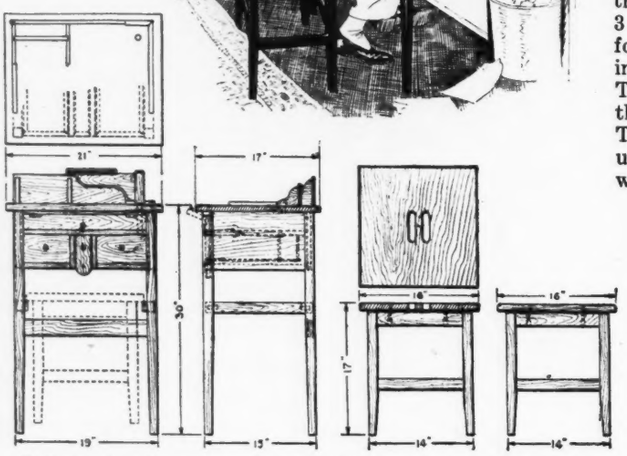
Fig. 2—Saw vises and diagrams to aid you in sharpening your saws

Telephone Table Serves as Writing Desk

THE addition of drawers for "3 by 5" filing cards and a rack for stationery makes this telephone table a particularly useful piece of furniture, and it can be used, when necessary, as a writing table. The telephone rests on a swinging arm and turns back out of the way when not in use. A compartment with a door that lifts is provided for telephone directories.

The stool is kept under the table except when needed, and slides on two runners, so that there will be no danger of scraping the floor or racking the stool in handling it.

Both the table and stool are of the simplest construction. They can be made of oak, gumwood, or mahogany, or of one of the cheaper woods, such as birch or whitewood, and stained or enameled to match other pieces of furniture in the room in which they are to be used.



Full size details and complete bill of materials for this attractive telephone table and stool are contained in Home Workshop Blueprint No. 18

Some Dimensions

The table top is 17 by 21 in. and stands 30 in. high. The telephone arm has a round spindle that passes through the top and the first shelf and serves as a pivot. A stationery rack is provided at the back, to the left of the telephone arm, thus giving the table its right to pose as a desk.

Directly beneath the top is the directory compartment, which should be no larger than necessary to hold the telephone books. For very thick directories, such as the New York City directory, the depth of the compartment should be increased accordingly. This space is closed by a door hinged at the top, with a knob for lifting it.

Filing Cabinet Is Included

Below the directory compartment are three drawers, two of them for holding 3 by 5 in. cards. These cards can be used for names and addresses, memoranda, and indexes that it is desired to keep handy. The drawers are each 12 in. long inside, so they will hold a large number of cards. The center drawer is narrow and may be used for pens, pencils, ink, and other writing materials.

The stool stands 17 in. high and has a top 16 in. square, in which two holes are cut to provide a hand grip.

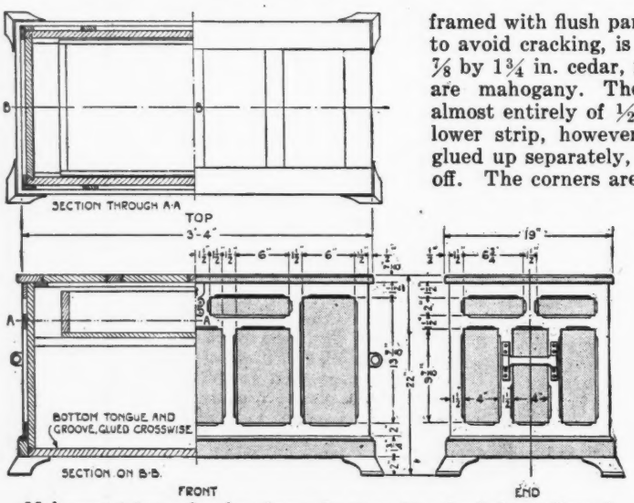
If oak is used, and there is no need for matching, try a more unusual finish, such as frost oak or forest green.

The full working details of the telephone table and stool and a complete bill of materials are contained on a 15 by 22 in. blueprint (No. 18) that can be obtained for 25c from the Blueprint Service Department, POPULAR SCIENCE MONTHLY, 225 West 39th Street, New York.

How to Build a Cedar Chest that Will Last for Generations

FEW pieces of furniture that the home worker can make are more appreciated or will better repay his efforts than a cedar chest. It is comparatively easy to build a chest, the material costs comparatively little, and if care is taken in selecting a good design and working out the details accurately, the home mechanic is pretty sure to make a finer chest than the average commercial one.

A good chest improves with age and often becomes a family heirloom. The rich coloring of Tennessee cedar is never tiresome and deepens with age. And the usefulness of a cedar chest goes without saying, as it forms an ideal storage place for furs, linens, and valuable fabrics, serving as a hold-all.



Mahogany trimmed cedar chest, the parts in cedar being indicated by the half tone shading. Blueprint No. 17 gives additional details

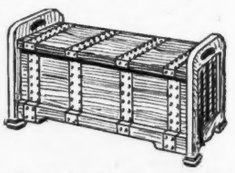
Simple chest with copper bands

One of the most strikingly beautiful chests that the home craftsman can make is the mahogany trimmed chest illustrated at top center. It is a red cedar box, with simply made joints, to which are applied frames of thin mahogany. These form a panel effect and the contrast between the two beautiful woods enhances the grain and coloring of each of them so that the result is exceptionally fine.

The chest proper is 3 ft. 2 in. long, 17 in. wide and 19 in. high. The top, which is framed with flush panels for the sake of durability and to avoid cracking, is 19 in. by 3 ft. 4 in. The base is ⅞ by 1¾ in. cedar, mitered at the corners. The feet are mahogany. The mahogany frames are made almost entirely of ½ or ⅜ in. by 1½ in. strips. The lower strip, however, is 2 in. wide. Each frame is glued up separately, chamfered as shown, and cleaned off. The corners are then mitered and the frames are glued to the cedar box and held in place while the glue is setting with hand screws and, if necessary, a few brads. A simple mahogany molding is mitered around the chest above the base.

The escutcheon for a chest of this character should be handmade, if possible. The design for the one shown on the chest is based on a four-leaf clover motive. The handles are shaped from maple fastened to the ends with countersunk bolts. Strips of brass or copper are then screwed over the handle ends as illustrated.

A commercial chest in walnut and cedar

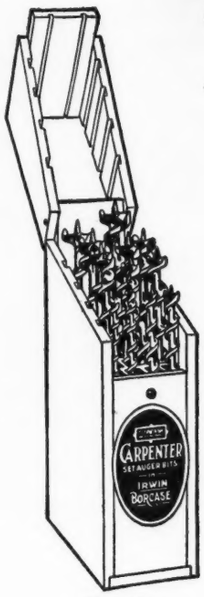


Seat chest of standard design

A sliding tray, 6 in. less in length than the inside length of the chest and 4½ in. deep inside, is provided, and for durability the joints should be dovetailed. Two or three ordinary chest hinges may be used with the offset flaps sunk sufficiently into the cedar to allow for the additional thickness of the mahogany trim. For a finer construction, continuous nickel-

(*Continued on page 100*)

The IRWIN Line of AUGER BIT SETS



The *New* Irwin Borcase

THE IRWIN BIT SETS are the newest thing in fine tools. The *new* Borcase and Borkit illustrated are both *exclusive* features of the Irwin line.

Both the case and the kit of bits are made so that all the bits can be kept in the order of their sizes. This means quick selection of the exact size needed.

In the *new* Irwin Borcase and Borkit all bits are protected from rust—and as they don't come in contact with other tools they keep their keen cutting edges.

THE BORCASE is made of matched hardwood, tongued and grooved; glued, pressed and nailed. A positive lock keeps out the rust and dust. Handsomely finished with two coats of water-proof shellac.

THE BORKIT is made of eight ounce slate colored duck, bound with braid. To prevent rust and dust the kit is lined with non-tarnishable green flannel. A strong web strap and heavily nickeled buckle keeps the kit snugly closed when not in use.

For the Home Craftsman

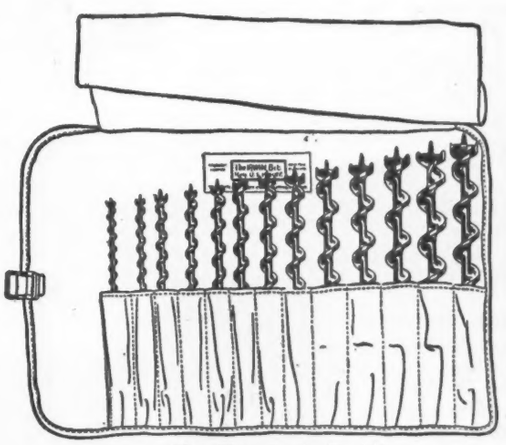
Readers of the Popular Science Monthly's Home Workshop pages will find Irwin Auger Bits in the handsome *new* box or kit just what they need for doing fine work.

A bit for every purpose will help you turn out clean, workmanlike jobs. Irwin Bits come in sets of six, ten and thirteen bits.

Carpenters and cabinetmakers use more Irwin Bits than any other bits made. For good work use the same bits used by professional tool users.

Do you know the names of the three major parts of a bit?—what the opening connecting the cutting edge with the twist is called?—what a *solid center* bit is? You will find these and scores of other questions answered in our book.

Every man who loves tools will want a copy of the interesting and useful book *"How to Select, Use and Care for Bits."* We will be glad to send you free a copy of this illustrated book.



The *New* Irwin Borkit

Dealers: Your customers will want the Irwin Bit Sets in the handsome *new* boxes and kits. Attention arresting window and counter displays can be built around the *new* Irwin Borcase and Borkit. If you are stocking them, play them up strong. If you haven't seen the *new* Irwin Sets write us to-day for full information.

THE IRWIN AUGER BIT CO.
WILMINGTON, OHIO.

Originators of the solid center principle and sole manufacturers of the genuine Irwin line of bits and Augers.

Standardize The IRWIN Bit Reg. U.S. Pat. Office *on IRWIN*

"The Man of a Thousand Tools"

By Lorry Jacobs

DOES your daily work grow dull sometimes? Do you feel misplaced in the thing that you are doing? Would you like to find a healthful hobby that would bring you both recreation and additional income?

Then listen to this story of "The Man of a Thousand Tools," who spent 29 of his working years working at jobs that failed to interest him or bring him the joy of accomplishment. Clement Hopkins of New York did this—and then suddenly found the thing to which he had unknowingly been suited all his life—woodcarving. And he mastered it completely in the short time of three years.

For 29 years, the man now known as "The Man of a Thousand Tools" worked variously as an actor, a stage manager, and at the clerical work to which he was forced to retire when his health forbade his traveling. And he felt, more and more, that he must get relief from the sedentary work that occupied eight hours of every day. But he kept on, not realizing what was the matter with him, until a serious illness forced physicians to tell him that he must find an activity to occupy his spare hours—some sort of a hobby in which he could really feel an interest.

Began with a Few Chisels

Hopkins cast about vaguely. Then fingers communicated to his mind the fact that they wanted to be working with something. He immediately set out for the nearest tool store and the nearest five-, ten-, and fifteen-cent store. There he bought half a dozen carving tools and a cheap wooden frame.

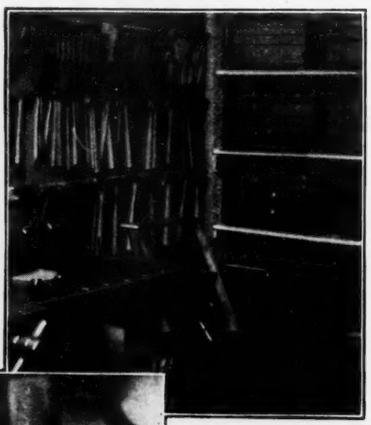
There are some men who take naturally to toosl. Hopkins always had an aptitude for doing things of a mechanical nature, but he did not regard this as anything unusual. So, with his carving tools, but no great enthusiasm, he set to work to try and embellish the simple frame he had bought. In a short time the homely piece of wood had taken on a graceful design that surprised his friends and Hopkins even more!

That was the start. Then followed a thorough study of the history of woodcarving; evenings spent in examining illustrations of the beautiful designs wrought in wood of other days; weeks spent in experimenting with the use of new tools he began to accumulate; and then, a real effort to emulate in beauty some of the more simple masterpieces he had been studying.

All that was three years ago. At that time, Hopkins could not tell a framing chisel from a fishtail gouge. Today he has a brilliant and remunerative future ahead of him as a woodcarver, knows the use of every woodcarving tool, and has an interest in life that has restored his health and given him a joy in living.

"THE greatest thing my work has given me," says Clement Hopkins, expert woodcarver, "is the realization that there are probably thousands of boys who have no chance to allow their fingers to show their skill.

"My greatest dream is the establishment of a free school - workshop, where I can teach such boys a marvelous way of making a living"



The man of a thousand tools at work, and, above, a corner of one of his toolrooms

His equipment of tools runs into the thousands, ranging from chisels and gouges that will give an incision of the fineness of a hair, to huge tools with a 2-in. sweep.

He has sets upon sets of straight chisels and bent, fluters, parting tools, long and short bent gouges, a hundred hammers, saws, mallets, planes, and a lathe for turning out round pieces to fit some intricate design. His tools fill three rooms and he has 38 toolchests.

To see Hopkins working in his little studio perched on the top floor of a typical dark-halled tenement in the outskirts of Greenwich Village, Manhattan, you would think that he had spent his life working in his chosen profession. He has accomplished what seems to be a miracle in three short years.

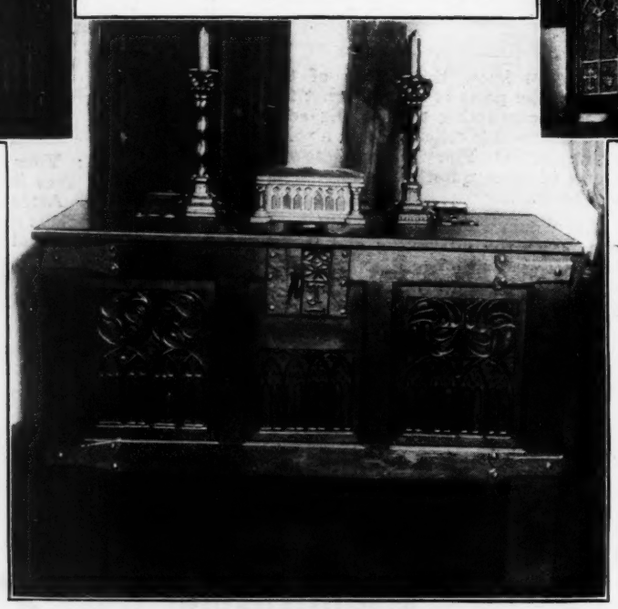
Using all his spare time, Hopkins carved scores of frames, never two alike, and then turned his attention to triptychs, these shrinelike altar pieces of ecclesiastical design, with two doors that open and disclose the contents. To copy some of the medieval designs more perfectly, Hopkins even learned the art of gilding. And for these he found a ready market that helped pay for the tools he had collected.

Carving a $1000 Chest

The harder he worked, the greater grew his ambition. Wondering what commercial value his work had, he took several pieces to a Fifth Avenue art dealer. The man was amazed that Hopkins had mastered the difficult art in so short a time without training. There, Hopkins noticed a fifteenth-century carved walnut chest. Making inquiry, he found that complete photographs of the chest were in a book in the Public Library. He secured a photograph and after several months of tedious labor, completed an exact replica, making each part in cheaper wood first, to be sure of himself. For the ornate hinges, side irons, and a big lock and key made of hand-forged iron work, he engaged the aid of artisans, who duplicated it to a nicety. Finished, the chest sold for nearly a thousand dollars. Hopkins had another chest of white wood, also a replica, but that was for his own home.

Orders for triptychs and frames kept pouring in, some even coming from Europe. Finally came an order for a pulpit, which will far surpass anything Hopkins has ever attempted, with its symbolic and ecclesiastical figures to be done in high relief and its Gothic lettering. This completed, he will go on making furniture.

Yet he is the man who three years ago did not know what to do because his work did not give him the joy of living that makes life worth while!



The remarkable beauty and character of Mr. Hopkins' carving is revealed in this reproduction of an antique Italian walnut chest and, above, two triptychs

The Proper Finish Will Make Your Furniture Harmonize

Small odd pieces of modern furniture add greatly to the attractiveness of every home. You, yourself, can easily make them for your family. There is no particular trick to constructing porch swings, tables, telephone sets, etc.

Furniture, woodwork and floors of your home can be made to harmonize if a little taste is used in finishing them. You can easily refinish dingy, shabby, scratched wood. Our method involves practically no expense. All you need is a little time—a brush—and JOHNSON'S WOOD DYE.

Johnson's Wood Dye is very easy to apply—it goes on easily and quickly, without a lap or a streak. It penetrates deeply, bringing out the beauty of the grain without raising it—dries in 4 hours and does not rub off or smudge.

JOHNSON'S WOOD DYE

Johnson's Wood Dye is made in fourteen beautiful shades, all of which may be easily lightened or darkened—full directions on every label.

In Wood Finishes you get just what you pay for. If you buy cheap brands you may be sure they are manufactured from cheap raw materials, cheap labor and the completed job will be a disappointment and the finish will not stand up.

The Johnson Line of Artistic Wood Finishes is complete—it includes Johnson's Wood Dye—Paste Wood Filler—Enamel and Undercoat—Permacote Wall Finish—Floor and Sani-Spar Varnish—Prepared Wax—and everything necessary for your furniture, floors and trim.

If you are building or remodeling you should have our book on refinishing. The finish of your floors and interior trim is a matter of great importance, for a beautiful piece of hard wood may be absolutely ruined with the improper finish, whereas an ordinary piece of wood is a pleasure to the eye if well finished.

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This Book tells how to finish wood in artistic stained and enameled effects. Gives practical suggestions on making your home artistic, cheery and inviting. Tells just what materials to use and how to apply them. Includes color card—gives covering capacities, etc. Use coupon below.

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Better Shop Methods

How Expert Mechanics Save Time and Labor

Broaching Lowers Costs in Many Machine Shop Jobs

By Joe V. Romig

BROACHING is often the quickest and most satisfactory way of finishing the interior surfaces of oddly shaped holes, and sometimes the only one.

Square, rectangular, and splined holes, used in automobile construction, are invariably made by the broaching process. While machine broaching pays only when done on a production basis, nevertheless, small broaches, such as are pushed through the job under a power or arbor press, are becoming more popular and more used every day.

No modern toolmaker's kit is complete if it does not contain a set of a few assorted square and rectangular broaches. Tool slots in boring bars and tool holders and square and rectangular holes in jigs and tool fixtures can be cut with small broaches that the average mechanic can easily make himself. A useful set of small broaches for the toolmaker is shown in the accompanying illustration. A good grade of carbon steel must be used for the broaches; a carbon content .90 to 1.10 is about right.

Designing and Making Broaches

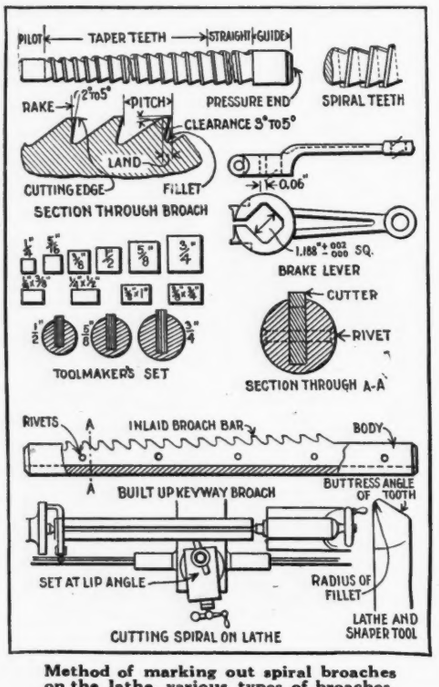
In designing a broach, several things must be noted, such as the kind of metal to be worked, the thickness of the work and the amount of metal to be removed by the cutting teeth. Thin pieces require a broach with closely spaced teeth. The amount of metal removed decides the chip room and the metal to be cut determines the lip and clearance angles of the teeth.

The parts of a broach's anatomy are the pilot, which must be turned to a few thousandths of an inch smaller than the hole into which it is to enter; the body, which is tapered to allow each successive tooth to do its share of the cut, and the sizing portion, which usually contains about six teeth, all the same in size, their function being to finish the surface of the hole accurately to size. The head is made a few thousandths smaller than the sizing teeth and acts as a guide member in keeping the sizing teeth in perfect line while passing out through the hole. Whenever possible, broaches should be made with spiral teeth, as this type takes a shearing cut, eliminates chattering and digging in, and, as the spiral effect staggers the teeth on opposite sides, the broach works better in thin pieces.

After the broach blank has been shaped up to the proper size, it is centered on the lathe, the feed screw is geared to the desired pitch, and a tool, as shown, is used to cut the spiral on the corners of the broach, leaving a land at least 1/16 in. wide. It is then an easy matter to set up the blank broach in the vise on the shaper and cut the teeth to the proper angle by throwing the vise over to the angle of the marked spiral.

After the teeth have all been roughed out, the broach must be annealed to prevent the trouble caused by warping, which often spoils an otherwise good broach. The annealing takes out the internal strains of the metal and softens it for the final finishing of the teeth, which is usually done with a fine file. Care must be exercised in obtaining the proper clearance angle of the cutting edge, which varies from 3 to 5 degrees. Blue paint is smeared on the land section before filing, so that it can easily be seen when the exact cutting edge has been reached.

The proper hardening and drawing of the temper determines the durability of the broach. A hard broach will break and a soft one will wear out quickly. An oil or gas furnace should be used in hardening so that the piece can be heated evenly to the proper temperature recommended by the steel company that supplies the steel. To heat a broach in an open coal fire invites ruin because of scaling and burning. If no other fire is available but a coal fire, protect the broach from the flames by first laying in several pieces of wood, and let them char thoroughly.



Method of marking out spiral broaches on the lathe, various types of broaches, and a small job upon which broaching saved money

Care Needed in Tempering

In the quenching, too, much care is necessary. If the broach is cooled unevenly, it will warp. Upon withdrawing it from the furnace or fire, immerse it vertically in a tub of water and stir it around in small spirals, increasing in size until the piece has cooled. Test with a file for hardness and then shine up the lands of the teeth with emery cloth prior to drawing the temper.

Temper can be drawn on small broaches in sand heated over a bunsen burner, or in the open flame of a bunsen burner. By drawing and quenching several times the most uniform results will be obtained. In each individual drawing, allow the heating to take place slowly, so that the heat will penetrate to the interior of the body. For general use a broach made of good carbon steel should be drawn to a medium straw color, or a little darker.

Broaches should not be used to shape and size rough cored holes, as the sand and scale will ruin the teeth at one passage. Rough or cored holes are first prepared by drifting them out with a solid drift, leaving just sufficient metal in the hole for the final sizing. Lard oil is an ideal lubricant for use in broaching; it finishes well and cuts freely.

An example of successful broaching is illustrated to show the practicability of broaching for saving labor and money when the quantity of work is sufficiently large to warrant the expense of making the broaches.

An automobile maker sublet a contract for the machining of several thousand brake levers to a small machine concern, with whom the writer was at that time connected in the capacity of machine superintendent. The designer of this part of the truck called on his print for a cored hole filed out to fit the squared ends of the brake shafts. When the lot of castings arrived, we found that the cores had evidently shrunk, as the holes were all about 1/32 in. too small.

Last Piece "Mikes" like the First

We decided at once to broach, and started that same day to drift out the scale and sand, while working on the broach itself. Broaching was done on a small power press, and one broach machined the whole lot of steel castings, the last hole looking and "miking" just the same as the first.

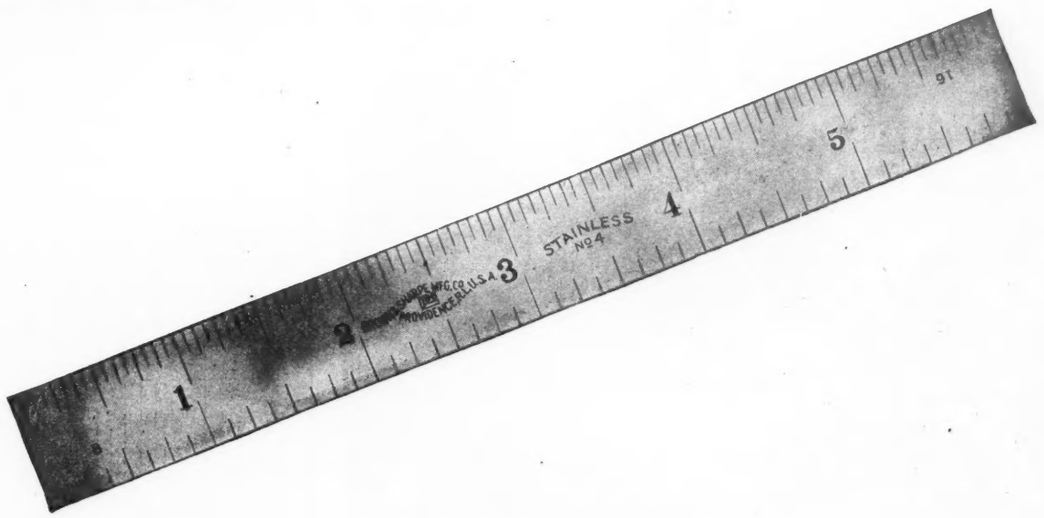
It is this exactness and perfection of machining duplicate work that makes broaching such a well liked and paying proposition. Broaching appeals to the manufacturer as a means of doing high class work quickly and cheaply with unskilled labor.

Some private sets of broaches I have seen included, besides the regular complement of square and rectangular shapes, round ones as well, and also small keyway broaches for cutting the keyways in small gears from ½ in. up to and including 1 in. in diameter. For the model builder and home workshop mechanic, a set of square and rectangular broaches will make for better and more accurate work.

Shims Make Erasing Shields

VERY thin shim stock, such as is used for liners for connecting-rod bearings, will make good erasing shields. Holes can be cut in it with a knife to permit the correcting of small details that could not be erased without damaging surrounding parts, even with the ordinary commercial shield.—JOHN KILIAN.

and Now—



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STAINLESS STEEL

by

BROWN & SHARPE

RUST-PROOF—will not stain or discolor, but will always retain its bright finish—clean cut graduations in 8ths, 16ths, 32nds and 64ths, of the characteristic Brown & Sharpe accuracy.

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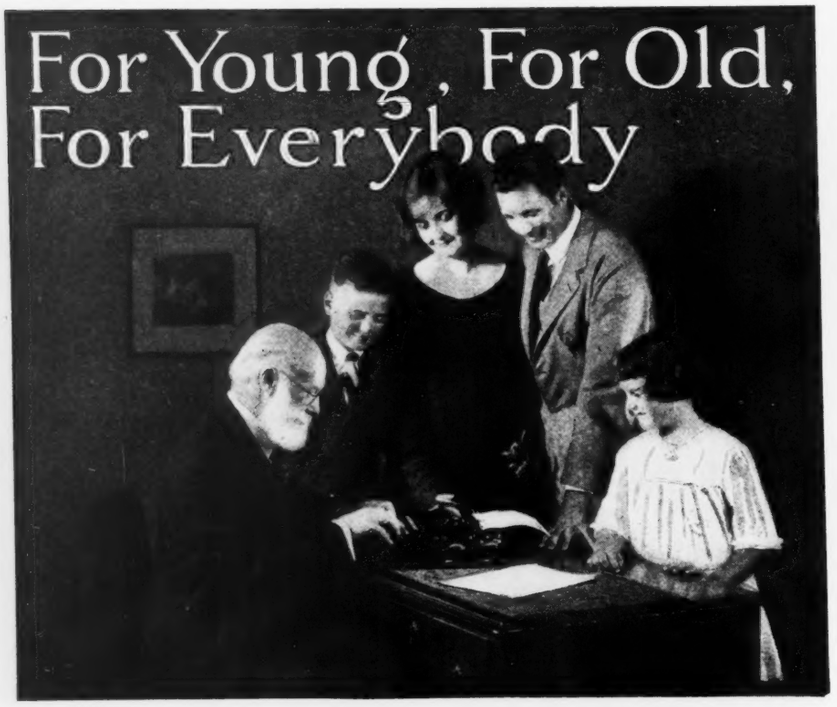

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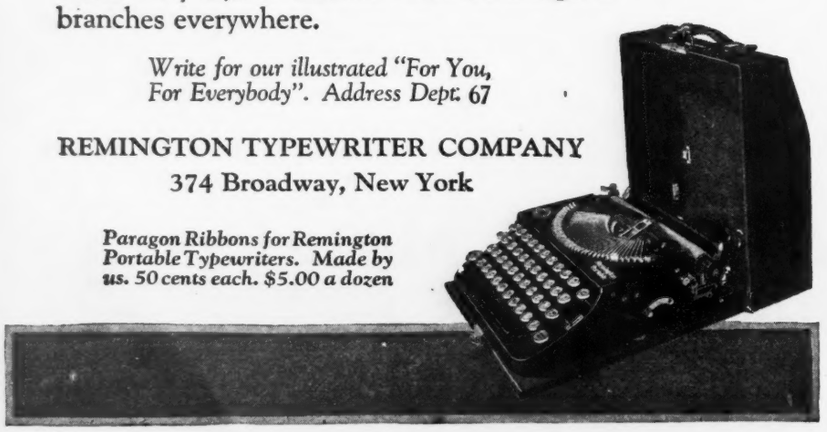


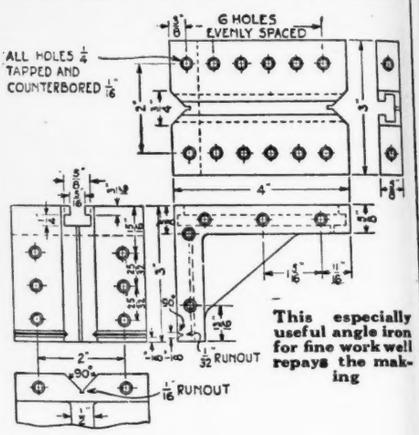
BETTER SHOP METHODS

Machinist Can Make His Own Angle Iron Pattern

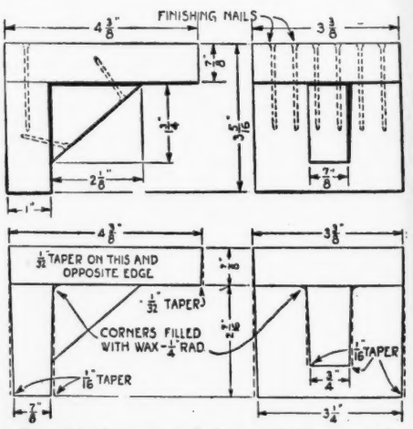
By Henry S. Laraby

AN ANGLE iron of cast iron is generally recognized as the most accurate of all the angle iron family. It seldom changes when once it is thoroughly seasoned. Making it is much cheaper than to hog an angle iron from a block of steel, and is much less discouraging, especially if the steel happens to crack in hardening.

Although the making of a wooden pattern is somewhat of a mystery to many mechanics, it is really quite easy to provide one for this angle iron, and after the pattern is made, the cost of casting is small. I made a pattern at one time and sold the castings in the toolroom for four dollars each, and they cost me only 30 cents. The pattern has been simplified as much as possible and it is merely necessary to follow the dimensions without considering the allowance necessary for finish and shrinkage, which have been taken care of in the drawing. The pattern is shown both before and after the draft is put on.



This especially useful angle iron for fine work well repays the making



The simple pattern before and after providing the draft. The dimensions shown include the necessary shrinkage allowance

The heads of the nails are set below the surface of the wood and the pattern is sandpapered and given one coat of shellac. After this is dry, the pattern is again sandpapered. The nail holes and the corners are filled with wax and two more coats of shellac are applied, care being taken to allow each coat to dry thoroughly and to sandpaper the pattern after each coat. The pattern is then ready for the foundry. It is best to have the cast made in gray iron.

(Continued on page 86)

With SARGENT PLANES "making things" is pure delight!

Why, the job is half done when a fellow starts with tools as fine as these Sargent Planes. And it's easier to do the careful, finished work you can be proud of. See these planes at a dealer's to-day. Buy them and realize tool perfection!

Auto-Set Bench Plane with the new chromium steel cutter that keep an edge. So rigid it will not chatter on hard wood and knotty or other difficult surfaces, even when cutting across the grain. It may be adjusted quickly for coarse or fine cuts. The clamp, when replaced after removal, will always return to its original position. A fine, capable, all-round plane for your workshop.

Steel Pocket Plane and Steel Block Plane are light and indestructible. They are particularly handy for fitting corners, etc., and for the delicate finishing touches to your craftsmanship.

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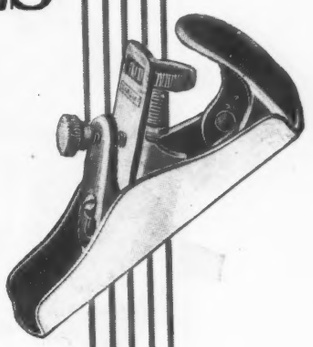
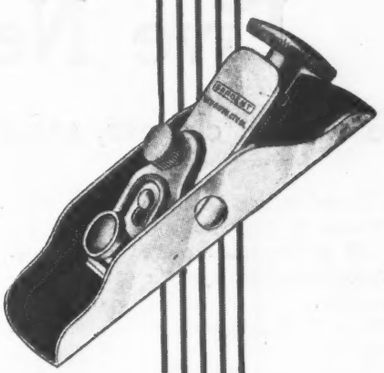
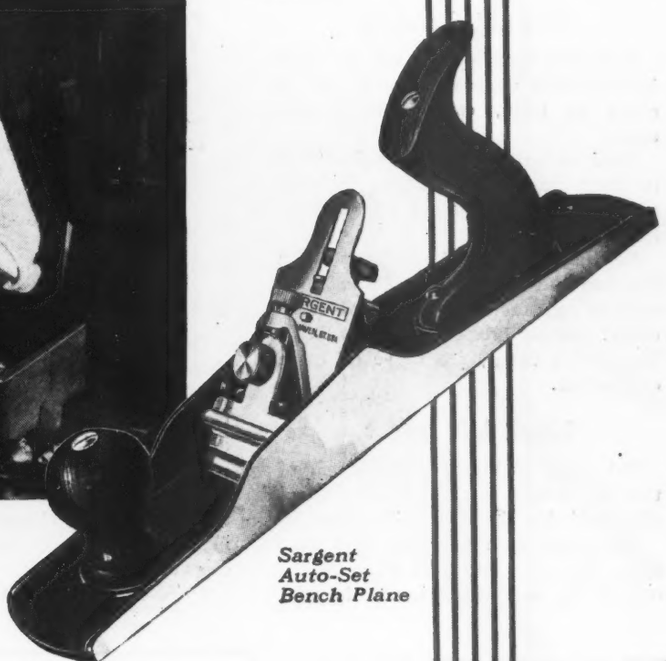


Sargent Pocket Plane



Sargent Steel Block Plane

He is using the Sargent Auto-Set Bench Plane in fitting a drawer. This plane will come into use more frequently than any other in your equipment. It is so sturdy it will do heavy work without complaining, but so handy it can be used on the finer jobs, too.



Sargent Auto-Set Bench Plane

SARGENT

Tools & Hardware

Five New Ways

To whiter, cleaner, safer teeth—all late discoveries

Dental science has been seeking ways to better tooth protection.

All old methods proved inadequate. Tooth troubles were constantly increasing. Very few escaped them. Beautiful teeth were seen less often than now.

Dental research found the causes, then evolved five new ways to correct them.

The chief enemy

The chief tooth enemy was found to be film—that viscous film you feel. It clings to teeth, enters crevices and stays.

Food stains, etc., discolor it. Then it forms dingy coats. Tartar is based on film. Most teeth are thus clouded more or less.

Film also holds food substance which ferments and forms acids. It holds the acids in contact with the teeth to cause decay. Germs breed by millions in it. They, with tartar, are the chief cause of pyorrhea.

Much left intact

Old ways of brushing left much of that film intact, to cloud the teeth and night and day threaten serious damage.

Two ways were found to fight that film. One acts to curdle film, one to remove it, and without any harmful scouring. Able authorities proved those methods effective. They were embodied in a tooth paste called Pepsodent, and dentists the world over began to urge its use.

Other essentials

Other effects were found necessary, and ways were discovered to bring them. All are now embodied in Pepsodent.

Pepsodent stimulates the salivary flow —Nature's great tooth-protector.

It multiplies the alkalinity of the saliva. That is there to neutralize mouth acids, the cause of tooth decay.

It multiplies the starch digestant in the saliva. That is there to digest starch deposits on teeth which may otherwise ferment and form acids.

It polishes the teeth so film less easily adheres.

Prettier teeth came to millions

One result is prettier teeth. You see them everywhere—teeth you envy, maybe. But that is only a sign of cleaner, safer teeth. Film-coats, acids and deposits are effectively combated.

Send the coupon for a 10-Day Tube. Note how clean the teeth feel after using. Mark the absence of the viscous film. See how teeth whiten as the film-coats disappear.

Cut out the coupon now.

Pepsodent PAT. OFF. REG. U.S.

The New-Day Dentifrice

A scientific film combatant, which whitens, cleans and protects the teeth without the use of harmful grit. Now advised by leading dentists the world over.

10-Day Tube Free 1014

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Mail 10-day tube of Pepsodent to

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. . . . . .

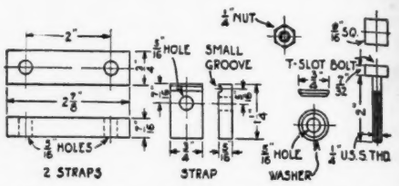
Only one tube to a family.

BETTER SHOP METHODS

Machinist Can Make Angle Iron

(*Continued from page 84*)

The casting should be milled on the inside and worked off on the outside in a shaper and laid aside for a week or more to season. It should finally be ground all over, except, of course, the inside. If the gray iron is close grained, it will hardly be possible to tell the piece from steel when finished.



Details of the straps and bolts used with the angle iron

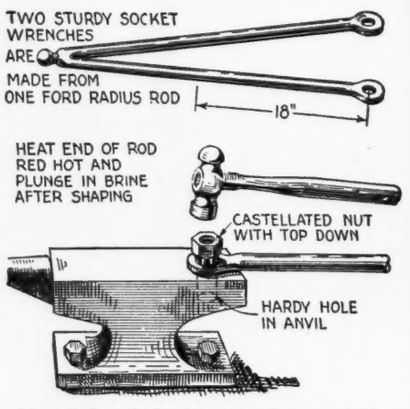
The small V may seem superfluous to some mechanics, but for any of the finer grades of work, such as gage or tool making, it will prove invaluable, as when it is needed, it is needed badly. The V on the top edge is for holding bosses and the like.

Some machinists may consider the dimensions I have given too light for average work, although they are those I have used for my own angle iron. It is, of course, a simple matter to make the pattern a little heavier; both legs, for instance, can be 1 in. thick, the bracket 3/8 in., and the finished dimensions in proportion.

Large Wrenches from Discarded Ford Radius Rods

RUGGED and substantial wrenches for tightening or loosening the nuts holding spring clips and automobile wheels may be made in a repair shop—where many of them are required—out of bent and broken front radius rods from Ford cars.

An 18-in. section of the radius rod, with the eye at the end, is cut off and the end is heated red. The castellated head of a nut is started in the eye after the red hot end of the rod has been placed over the hardy hole in the anvil, and the whole nut is driven through. While still hot the end is plunged into brine.


TWO STURDY SOCKET WRENCHES ARE MADE FROM ONE FORD RADIUS ROD
18"
HEAT END OF ROD RED HOT AND PLUNGE IN BRINE AFTER SHAPING
CASTELLATED NUT WITH TOP DOWN
HARDY HOLE IN ANVIL

Powerful tools for heavy work are quickly forged from old auto parts

The whole process of converting a radius rod into a wrench of this type takes less than ten minutes, and the resulting tool stands up under the hardest usage.—F.A.Y.

Creative Work demands NICHOLSON FILES

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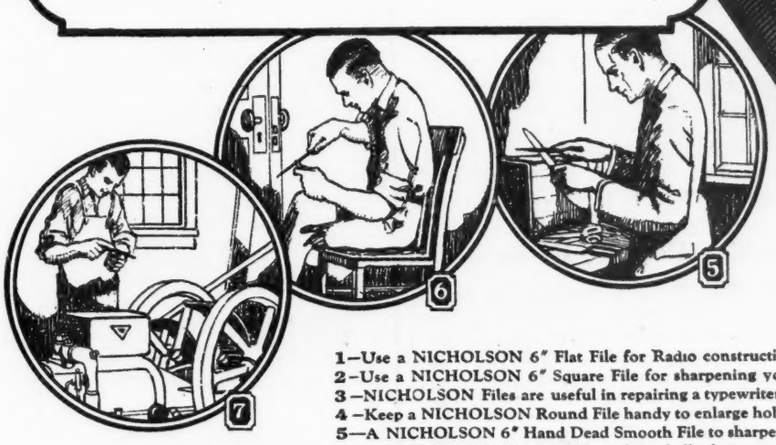
CONFIDENCE in your tools is the first step toward a good job—whatever you're attempting to make or repair.

That Nicholson Files are known and *used* by thousands of mechanics and skilled artisans in every civilized country, is proof positive that they have earned the confidence of men who know good tools.

Nicholson Files are scientifically tempered to hold their cutting edge under hard service. They feel right in the hand, cut right from the start, and save time and labor at the work bench.

When you tell your dealer you MUST have a NICHOLSON, you'll get the file you want.



1—Use a NICHOLSON 6" Flat File for Radio construction.
2—Use a NICHOLSON 6" Square File for sharpening your tools.
3—NICHOLSON Files are useful in repairing a typewriter.
4—Keep a NICHOLSON Round File handy to enlarge holes in metal or wood.
5—A NICHOLSON 6" Hand Dead Smooth File to sharpen knives and shears.
6—A NICHOLSON Warding File makes a balky key turn the lock.
7—A NICHOLSON Tungsten Point File is handy to have about when a gasoline engine shows ignition troubles.

NICHOLSON FILE CO.

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He smokes a meerschaum pipe fifty years old

Packed with Edgeworth he thinks no other pipe can compare with it

We have run on the case of three generations of pipe smokers preferring the meerschaum pipe to all other pipes. Not only that, but all three generations smoked the same meerschaum pipe (in turn, may we be allowed to add).

For further details we refer directly to the present owner of the ancient pipe.

"Dear Sirs," he wrote us, "I have a meerschaum pipe originally purchased and smoked by my grandfather. When he died, he willed it to my father, who smoked it continually throughout his lifetime.

"When the pipe came to me, I was a little dubious about accepting the family responsibility of keeping up the tradition. I tried several brands of tobacco in the pipe and they all made me sick. Then someone suggested Edgeworth.

"From that day to this I have smoked no other tobacco—no other pipe.

"Give me the old family meerschaum and a little blue can of Edgeworth and I can get all the enjoyment out of smoking there is any time of day or night.

"Perhaps I'm prejudiced, but that's the way I feel about pipe smoking. And that's the way I intend to feel as long as you continue to make Edgeworth."

Well, we can reassure our correspondent on that point, for we intend to go on making Edgeworth just as long as there are smokers who would give up smoking if they couldn't get Edgeworth.

And we intend to go on making friends for Edgeworth by sending out more free samples.

So if you haven't tried Edgeworth, send us your name and address and we will immediately forward to you generous helpings of both Edgeworth Plug Slice and Ready-Rubbed.

For the free samples, address Larus & Brother Company, 59 South 21st Street, Richmond, Va. If you will also include the name and address of your tobacco dealer, it will make it easier for you to get Edgeworth regularly if you should like it.

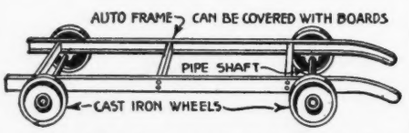
To Retail Tobacco Merchants: If your jobber cannot supply you with Edgeworth, Larus & Brother Company will gladly send you prepaid by parcel post a one- or two-dozen carton of any size of Edgeworth Plug Slice or Ready-Rubbed for the same price you would pay the jobber.

BETTER SHOP METHODS

Chassis Frame Converted into Strong Shop Truck

A SLIGHTLY bent and otherwise useless auto chassis will serve for the frame of a shop truck. Use solid steel shafting for the axles and clamp them to the under side of the frame, as shown. Handles may be provided at the rear so that the truck can be pushed back and forth. It is intended mainly for use along alleys and bins, where the track does not turn to the right or left.

Planks 2 in. thick are fastened to the frame to serve as a bottom for the truck.



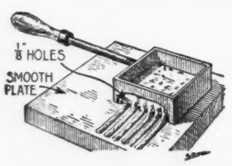
A truck for heavy work that will stand unlimited abuse

This is done by drilling holes in the channel iron and riveting on the boards. The wheels can be provided with solid rubber tires if the noise of the cast iron wheels is undesirable.—DALE R. VAN HORN.

Running Solder in Strips

IN THE small shop, where expenses must be kept down, it is customary to buy solder in its cheapest form—the pound bar. There are many jobs, however, that could be executed more easily if the solder were in the form of long, narrow strips similar to the higher priced commercial wire solder.

To make such strips it is merely necessary to use a simple cast iron ladle with several small holes drilled through the bottom, close to one of the sides. The ladle is tilted back a trifle and half filled with molten solder in such a way that the solder will not run out. It is then carried over a smooth iron plate and turned so that the solder runs out of the holes and forms long, narrow strips, as shown. These harden immediately upon striking the cold iron and can be removed as soon as they are poured.—C. M. WILCOX.

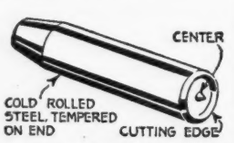


Shopmade wire solder

Marking Holes to Be Bored

A MACHINE shop making up some plates that had to be drilled with a large number of holes, but that could not be conveniently handled in a drill jig, used the special marking punch illustrated.

The tool was turned from cold rolled steel and the V marking edge was made the diameter of the holes that were to be drilled. The center extends beyond this edge and serves for locating the punch accurately. The tool was tempered, so that the circumference of the holes to be drilled could be marked distinctly after their centers had been fixed with a prickpunch.—L. S. R.



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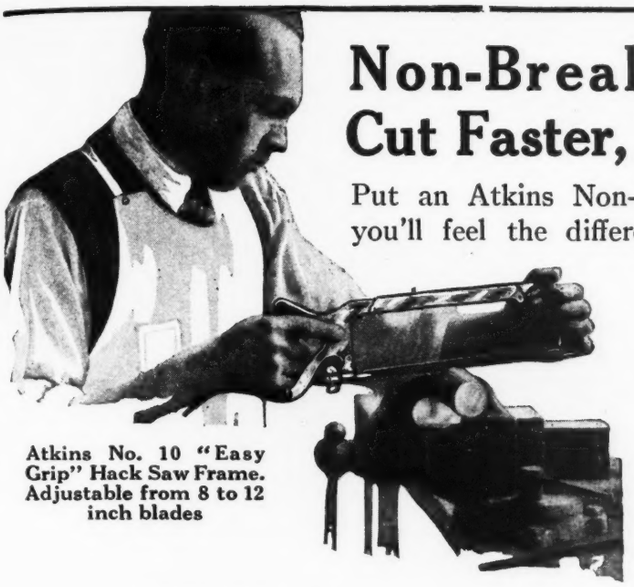

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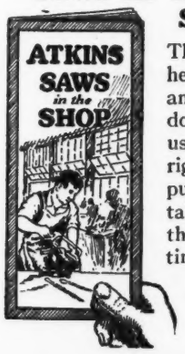

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BETTER SHOP METHODS

Making a Small Sheet Metal Punch Press

By Robert S. Lewis

WORK often done on sensitive drill presses, such as drilling rivet holes in thin sheet metal, could be accomplished more quickly and cheaply on a light punch press. Also, in the experimental departments and in the model building workshops of amateur mechanics, a small punch press is a handy tool.

A punch can be made with little trouble if square bar stock is used for a frame. For punching sheet stock up to ⅛ in. thick the power of a heavy hammer blow is sufficient; this does away with the need for cams or toggles.

The main frame of the punch press is made of two 1¼-in. square pieces of steel connected with two ⅝-in. cap screws, which run through the two round pillars, as shown. The pillars are turned and drilled out of cold rolled steel shafting.

The bottom part of the frame is mounted on an iron base, which is secured to the workbench by lag screws.

While individual punches are usually necessary, a single piece will answer for the dies. This die plate, made of tool steel, is fastened to lower member of the frame with a ½-in. flat head machine screw. It is indexed by means of a small index pin. In making this die plate, drill all the index holes as accurately as possible, clamp the die plate on the frame, and by using a sharp center punch in the punch holder, mark off the location of the holes; then drill and ream them to actual size.

Square, triangular, or any shaped holes can be made in the plate. A ½-in. hole central with the punch will allow the blanks to fall through.

The upper part of the frame is mounted squarely on the pillars in line with the lower part and is slotted for the adjustable guide bolt. It also is drilled on the forward end for the ⅞-in. punch holder spindle. This punch holder is flattened on its front face and is held from turning by a 5/16-in. screw and jam nut. On the punch holder is a special collar, which carries a thread for the punch retaining screw and also serves to prevent the punch holder from flying out of its hole.

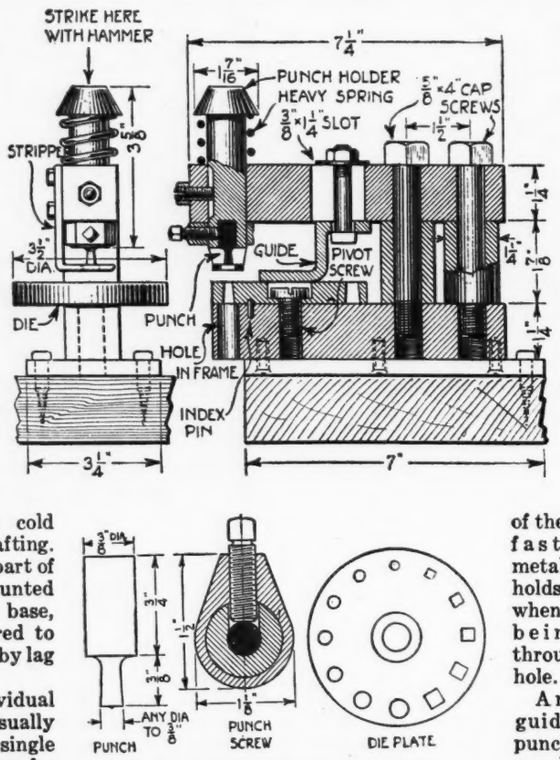
A rather heavy spring is placed between the conical head of the punch holder and the frame top. It cushions the blow after the punch has gone through the metal and returns the punch and spindle to their upper position.

To the side of the upper frame is fastened a sheet metal stripper, which holds the metal down when the punch is being drawn up through the punched hole.

An adjustable guide is used to punch a line of holes equally distant from the edge of a plate. This can be removed so that there will be a total clearance of 3½ in.

The hammer used to operate the punch should weigh about 5 lbs. Punches are made of ⅜-in. drill rod suitably hardened and drawn. The die plate is machined up and also hardened and drawn; it should be a good grade of carbon tool steel.

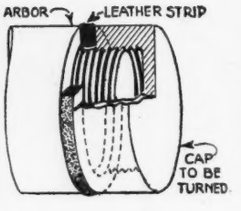
While this is a simple piece of mechanism to build, it will prove a valuable tool and will be appreciated by the workmen because of its small size and large capacity for work.



How this useful light punch press is put together, and details of the punch, punch screw, and die plate

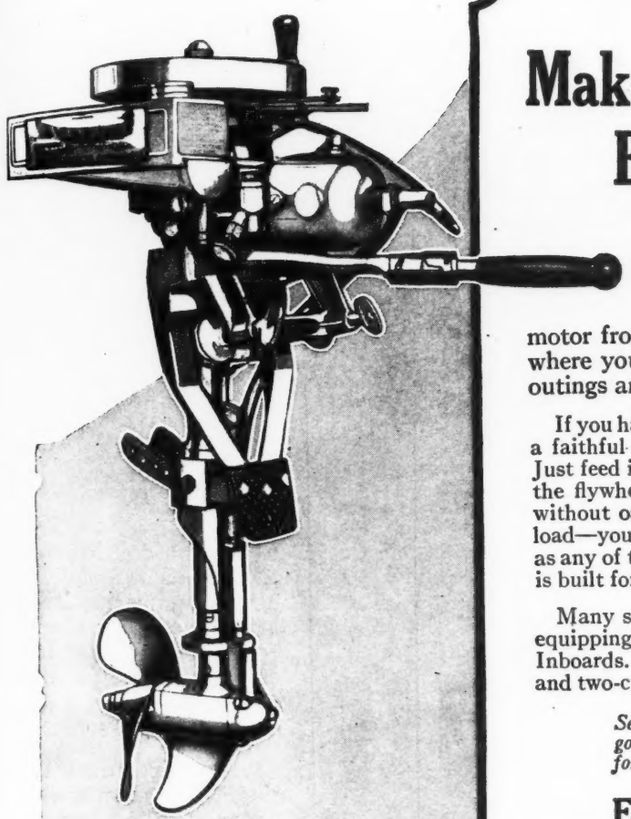
Leather Strip Prevents Screw Jamming

IT IS sometimes necessary to make a cap similar to that shown in the illustration, the outside having to be turned up smooth in a lathe. Where there are quantities to do, make an arbor to fit on, or in, the spindle of the lathe. Where there is but one or two to make, chuck a piece of scrap cast iron in the lathe chuck and make a temporary arbor.



Place a narrow strip of leather around the arbor between the shoulder on the arbor and the face of the cap. Then, when the job is done, pull out the leather and the cap can be unscrewed with the fingers. This method prevents the pressure of the cut from forcing the cap against the shoulder of the arbor so tightly that it is difficult to remove without marring or damaging it.

Be sure to use a strip of leather, not a collar or ring, so that one end can be pried up and the strip taken off easily.—W. D. T.



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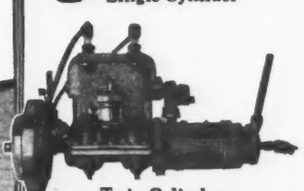

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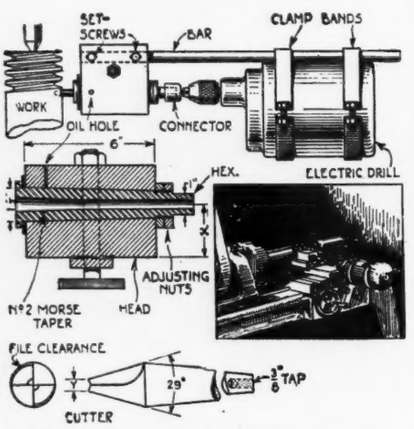
BETTER SHOP METHODS

Attachment Cuts Worms and Keyways in the Lathe

By James Ellis

THE popularity of worm and wheel reduction units among designers of various classes of machinery has made it necessary for our shop to make a great many worms at various times, and we felt the need of a process more efficient than chasing, yet not requiring costly equipment. The writer therefore designed the attachment illustrated. Since it was built, other uses have been found for it that are almost as valuable as that for which it was designed.

The device is simply a milling attachment for the lathe. The spindle is arranged to take a small end mill the shape of the thread to be cut, and the lathe is geared for the correct lead, as in chasing. Power for the cutter is provided by an electric drill



This small milling attachment, with its motor, is mounted on the compound rest of the lathe

clamped to a bar. The spindle is connected with the cutter spindle with a small universal joint. The average electric drill found in machine shops and garages has ample power for this work.

The head of the attachment is cast iron. It is provided with a key to fit the slot in the compound rest of the lathe. The distance *X* is made to fit the lathe to be used, the spindle of the attachment must be the same height as the lathe spindle. The type of bearing for the spindle may be varied to suit the builder, but a tapered bearing as shown is probably the best if carefully made, as it permits quick and accurate adjustments and at the same time is very rigid. A steel or bronze washer is doweled to the head and behind it are several washers of thin metal or paper, which are taken out when wear occurs to let the spindle go deeper into the tapered hole. On the other end of the spindle two adjusting nuts are provided.

A hole is drilled to take the 1-in. bar to which the electric drill is clamped. Setscrews hold the bar in place. A hole for a large headed bolt to fasten the attachment to the tool block of the lathe is drilled close to the center of the casting. The steel spindle has a shoulder on one end to take the end thrust and is threaded at the other for the adjusting nuts. The hole in it is bored to fit a No. 2 Morse taper shank and a 7/16-in. hole is drilled through to take a draw-in bolt with a thin head for securing the cutter. The back end of the spindle is

(*Continued on page 94*)

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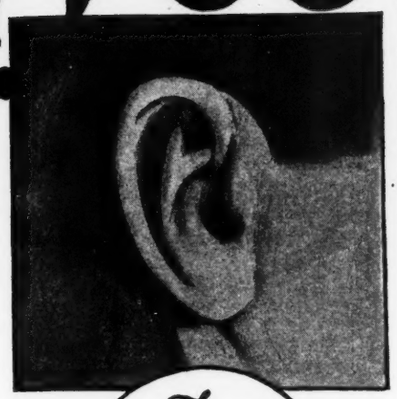

PLACE a record on your phonograph, drop the needle into place and the glorious tones of a famed tenor fairly shake the walls, the soft melody of a woman's voice charms the twilight, or the machine recreates the sound of violin or piano. You perceive these things by the sense of hearing, to be sure. But, behind the miracle that reproduces the sound waves, lie years of past toil and present accuracy in the perfection of every detail of the phonograph and record. Consider the record itself. It is a tough, elastic substance, composed of certain compounds that must be accurately blended. In this process, heat is employed. The control of this temperature must be exact if the finished "blank" is to prove properly susceptible to reproducing the sound waves when it is pressed by the master record. Behind the making of this master record itself—behind every step in its plating and electroplating, clear back to its production as a plaster cast of the original wax impression of the original harmony, the control of temperature—the "sixth sense"—plays its silent but vitally important part. The record of Tycos Tempe ature Indicating, Recording and Controlling Instruments furnish the means whereby this "sixth sense" has become as much a part of the everyday industrial world as the sense of hearing itself. The records you listen to are perfect because the records of the Tycos Instruments that controlled the temperatures employed in their physical production were perfect.

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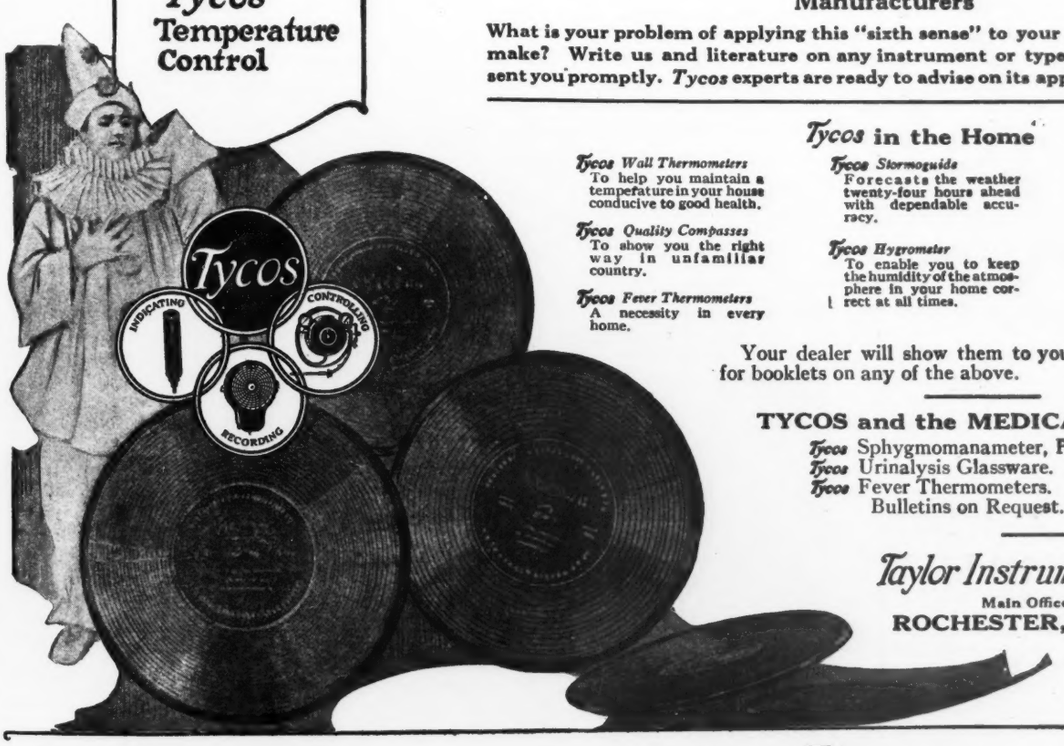

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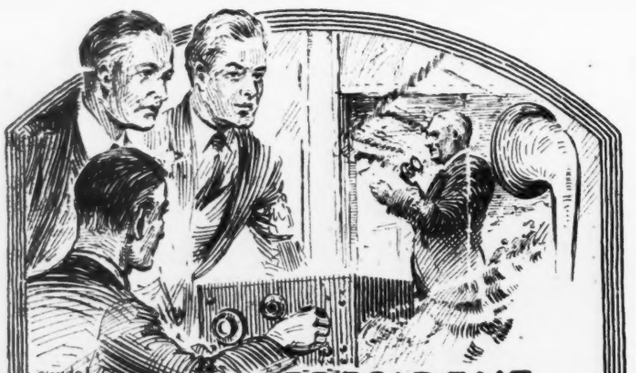

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1920 Sunnyside Ave., Dept. 1363, Chicago

BETTER SHOP METHODS

Attachment Cuts Worms

(*Continued from page 92*)

squared or "hexed" to fit a socket wrench and made to fit loosely over the end of the spindle. This is to give a certain amount of flexibility to the connection so that the drill need not be alined exactly and to permit the motor to be removed with very little trouble. The socket must be deep enough to go over the head of the bolt and the shank small enough to go in the drill chuck.

The cutters are made of tool steel. For the smaller sizes they are two-lipped; the larger ones have three or four teeth. The cutters are all made to the standard included angle of 29 degrees and vary for the different pitches by the size of the small diameter *Y*.

How the Device Is Operated

After the attachment is bolted to the tool block and the drill attached, the lathe is back geared and the gears to give the correct lead are put on. The blank is put between centers and the cutter set to cut the correct depth by measurement or by using the micrometer dial of the lathe. The carriage is run away from the work and the nut engaged. The belt is pulled by hand till the cutter is almost up to the work so that all lost motion in any of the parts is taken up. Now the drill is started and the pulling of the belt by hand continued. As the cutter enters the work, the behavior of the motor will tell whether the feed is too fast or too slow. If the feed is too fast, the drill will slow down, giving warning and protecting the cutter from breaking. Care should be taken to see that the feeding is regular and continuous. Do not jerk the belt. On small worms only one cut need be taken, but on coarse pitches it is advisable to divide the work between two cuts. If the thread is multiple, the indexing is accomplished in any of the usual ways, such as moving the carriage a definite distance. In cutting steel a copious supply of oil or cutting compound should be directed on the cutter.

Cuts Splines and Keyways

Another use to which this device is put is cutting keyways and splines in shafts. Tapered shafts, which are troublesome to set up on the milling machine, shafts with gears of other projections in place, may be keyseated without trouble with this device by using a small end mill.

We have built another of these attachments to fit a large lathe, 32-in. swing, and the attachment is used almost exclusively for keyseating. Large work that has been turned up can be keyseated before being taken out of the lathe, which effects a considerable saving of time in handling. Such work as heavy rolls too large to put on the milling machine table, complicated and cumbersome parts, such as dough mixer beaters or multiple throw crankshafts, may be put between centers and keyseated in a short time. This large attachment takes cutters with No. 3 shanks, has a worm and wheel drive of 10 to one ratio, to give more power to the cutter, and the electric drill stands parallel to the lathe axis.

A SLIGHTLY glazed emery wheel will produce a high polish on the work. An ordinary pebble rubbed on the wheel will produce the proper glaze for this purpose.

Go Where the Fish Are

Through the rushes and the lillies—the snaggy bay and rocky channel—go anywhere. The Elto is weedless and it safety-tilts when the propeller protector hits rock or snag. No injury to motor or boat. Go where the fish are!

An Extra H.P.–Full 3 H.P.

NOTWITHSTANDING its light weight, the Elto is the most powerful outboard motor — not just according to someone's "say-so", but by actual piston displacement. You need this extra H. P. to get speed from ordinary substantial boats—to buck river currents or headwinds and to carry loads. The Elto is the fastest most powerful light weight motor.

Easy starting and safety steering make it the family motor. You'll find no hard, stubborn starting with the Elto, because its Hot-Shot, waterproof battery gives it a spark so intense—so big and powerful, independent of cranking speed, that anyone can start the Elto with a quarter turn.

Safety Rudder Steering — does away with all possibility of dangerous pivot turning — lets you steer with tiller rope from any part of the boat — frees your hands for rod or gun except at turns — frees them from constant holding to a tiresome, shaky steering handle.

Fastest on any type of boat. The Elto has proven beyond all dispute to be the speediest, most powerful outboard motor. Wherever stock models are used, Elto leads in speed.

As light as right. Ole Evinrude, the pioneer outboard motor designer, who builds the Elto under personal direction, can be trusted to find that point where light weight, power, speed, and durability meet — to build light, but with no sacrifice of power, speed, bearing or wearing surfaces.

Ole Evinrude has built years of trouble-free service into the Elto. Ask for this, his latest motor, by name—the ELTO. The fast, light, easy-starting, vibrationless, 3 H. P. Twin. Grease-tight gear housing—silent underwater exhaust — quick reverse — weedless construction—folding rudder. Goes into carrying case without taking apart. Symmetrical design, beautiful finish. Write for catalog.

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I have found in outboard motor building that disalignments of shaft and gears cause strain, severe wear and consequently short life.

This has been eliminated in the Elto by the unique construction of its one-piece lower main frame which takes all shock and strain from the shaft in the same way as in the floating type automobile rear axle. The main frame houses the drive shaft in a way that protects it from all possibility of disalignment."

Cordially,

Ole Evinrude

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3 H.P. Fast Light Twin

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This Man Wouldn't Stay Down

HE was putting in long hours at unskilled work. His small pay scarcely lasted from week to week.

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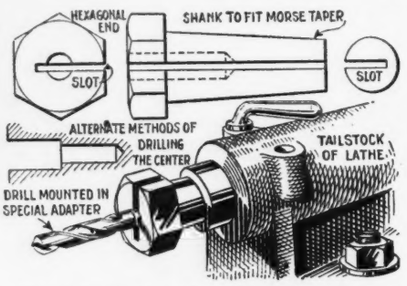
BETTER SHOP METHODS

Adapter for Lathe Tailstock Holds Small Drill

TO HOLD small drills in the tailstock of the lathe ordinarily requires either a small draw chuck or a wrench chuck with a Morse shank to fit in the spindle. A special adapter, made as illustrated, will take the place of such a chuck. It is a simple piece of bar stock turned with a



Simple in construction, this adapter serves as a chuck for small drills

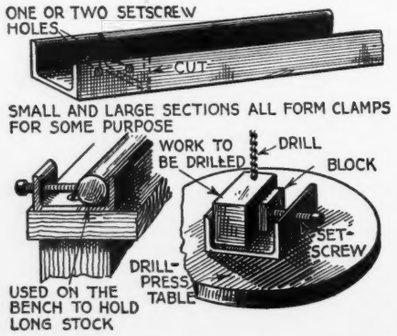
Morse taper shank and drilled with two holes, as shown, to accommodate the drills.

The forward hole can be made to fit a ¼-in. drill and the small hole a ⅛-in. drill. Other shanks can be made to accommodate other drills, if necessary.

The hexagonal end is for the purpose of taking the tool out of the spindle, while the lengthwise slot, which nearly severs the shank, allows the two sides to grip the drill when the shank is driven into the spindle hole. This unusually simple adapter is readily made up and saves much time and inconvenience in mounting a drill.—G. A.

Clamps Quickly Made from Short Lengths of Channel Steel

IN EVERY shop large clamps, small clamps, wide clamps, and all kinds of clamps are constantly in demand. Good serviceable ones may be made from ends of structural channels. These are cut up in convenient lengths and tapped for one or two setscrews, as shown. The screw is then used to clamp the work against the



Waste channels serve for cutting clamps of various sizes

opposite flange of the channel, and for fine work a block can be interposed between the work and the point of the screw.

For holding work on the drill-press table, for securing parts together while riveting, for holding long stock while sawing, and for hundreds of other purposes, these clamps will be useful. Whenever a length of channel is available, it is well to seize the opportunity to make one or more.—M.B.K.

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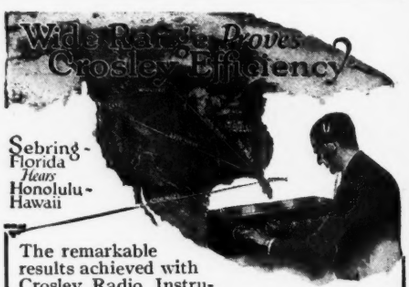

The remarkable results achieved with Crosley Radio Instruments are equaled only by their exceptionally low cost. A man in Sebring, Fla., using a Model X Crosley Instrument—Price only $55 for this four tube set—writes: "We are receiving from all standard stations north, east and west—from Winnipeg, New York City, Seattle and one night received three selections from K. D. Y. X. at Honolulu, Hawaii."

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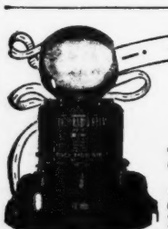

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For 55 years we have been making tools as well as we know how. Today it is safe to say there is not a community in all Christendom where Millers Falls Tools are not used by people who respect *fine* tools.

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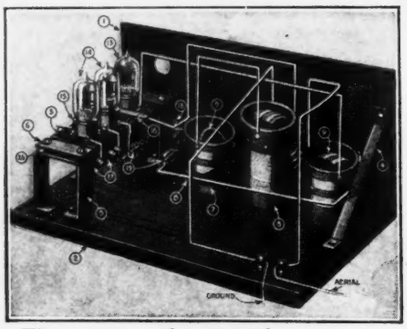

The vacuum tube set with two stages of amplification, from rear of panel

For men who like to make things at home with tools POPULAR SCIENCE MONTHLY is now publishing, in addition to its popular woodworking plans, an invaluable radio blueprint. This blueprint is easy to understand; the receiving set described requires the purchase of the fewest possible number of parts.

Should Receive 500 Miles

Under favorable conditions, if a long, high aerial is used, this receiving outfit will receive 500 miles. The blueprint contains working drawings, instructions, and bill of materials of a two-stage regenerative receiving set that a professional would be proud to own. It comprises a variocoupler and an Armstrong two-variometer-regenerative tuning circuit coupled, if desired, with two stages of audio frequency amplification.

The tuning coils have been selected because of the ease with which they may be constructed at home.

In this set has been incorporated the best features of several types of outfits. It will tune from 180 meters to about 600 meters with remarkable sharpness and selectivity.

Popular Science Monthly,
225 West 39th St., N. Y. City

Enclosed is 25c for which please send me the blueprint of the two-stage regenerative receiving set.

Name.....

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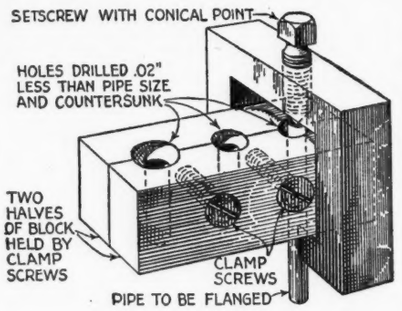
P. S. March

BETTER SHOP METHODS

Block Fixture for Forming Flanges on Copper Pipes

SUCCESS in making gasoline and oil line connections that will not leak depends mainly upon the flanging of the copper pipe. A shallow or an uneven flange is difficult to draw up firmly enough to prevent leakage, and there is danger of stripping the thread from the coupling in an effort to tighten the joint.

A fixture made as illustrated will flange the pipe to form a perfect seat and yet save considerable time over methods that involve the use of a hand flaring tool or punch and hammer. The device consists primarily of a block in which holes have been drilled of diameters slightly less than the stock sizes of pipe. These holes are countersunk and the block is cut in two after other holes are drilled and tapped for screws to hold the sections together.

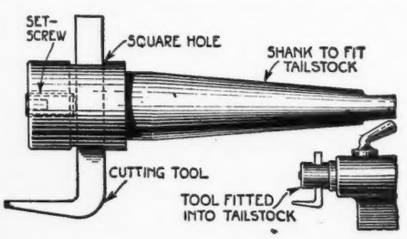

SETSCREW WITH CONICAL POINT
HOLES DRILLED .02" LESS THAN PIPE SIZE AND COUNTERSUNK
TWO HALVES OF BLOCK HELD BY CLAMP SCREWS
CLAMP SCREWS
PIPE TO BE FLANGED

Conical point on setscrew flares pipe for making gasoline and oil line connections

A block shaped like a square C clamp is made to fit over these parts. A ½-in. setscrew is fitted into the clamp, as shown, and the end of it is ground to a conical point. It is then only necessary to place the pipe in the fixture and screw down the setscrew. The pipe will not split unless it is hard, under which circumstances it should be annealed by heating and quenching in water.—L. D. J.

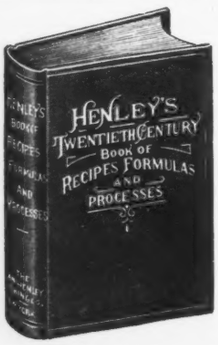
Special Lathe Tailstock Tool

ALTHOUGH many mechanics use only lathe tools erected in the toolpost of the lathe cross head, special tools for duplication work set into shanks fitting the tailstock are often advantageous in that tools for different purposes are made available without changing one for another.



Saves time in simple duplicate lathe work

For example, a large number of disks with a threaded shank were to be lathe turned. A shank was turned to fit the tailstock and one end of this was left large to accommodate a setscrew and tool. A suitable side cutting was then made as shown. The same shank could be used to hold tools of other shapes.—F. M. H.



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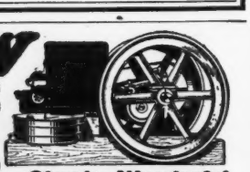

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In color, in beauty and uniformity of finish, Formica has for many years had no equal. It works splendidly with ordinary tools—maintains the highest dielectric strength and gets better with age.

Send for these leaflets:

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DEALERS:—The policy of the Formica Company is to co-operate aggressively with the jobber and dealer. You get prompt shipments, and high grade printed matter and sales helps for your store.

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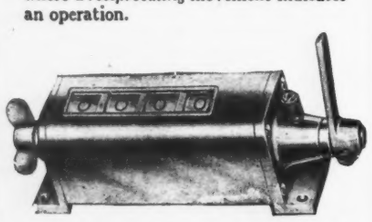
Maybe he's trying to *better* his record—at producing. Maybe he's only watching out to prevent a *poor* showing. In either case, his production is *HIGHER* because of a

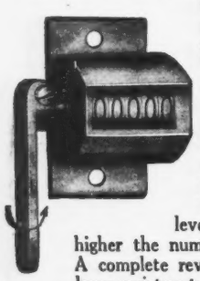
Veeder COUNTER

The Set-Back Rotary Ratchet Counter below is for machines such as presses and metal-stamping machines, where a *reciprocating* movement indicates an operation.



Registers one for each throw of the lever, and sets back to zero from any figure by turning knob once round. Supplied with from four to ten figure-wheels, as required. Price with four figures, as illustrated, $11.50—subject to discount. (*Cut less than ½ size.*) Set-Back *Revolution* Counter of similar model, $10.00 (list).

This small Rotary Ratchet Counter (No. 6) counts reciprocating movements of the lever, as required for recording the output of innumerable small machines. When the lever is moved through an angle of 40 to 60 degrees, the counter registers one. The further the lever is moved, the higher the number registered. A complete revolution of the lever registers ten. This counter can be adapted to no end of counting purposes, by regulating the throw of the lever. Price, $2.00. (*Cut nearly full size.*) Small *Revolution* Counter, also $2.00.



Everything you could ask in a counting device is shown in the new 80-page Veeder booklet. Ask for this foremost counter booklet.

The Veeder Mfg. Co.,
44 Sargeant St., Hartford, Conn.

The Home Workshop

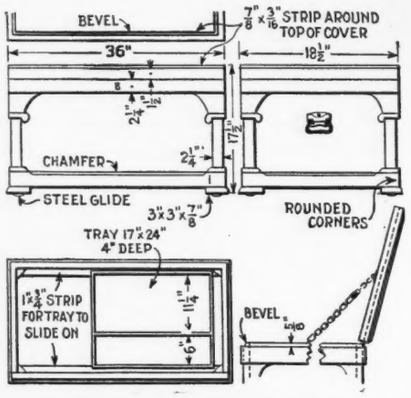
How to Build a Cedar Chest

(*Continued from page 78*)

plated hinges may be used, and two heavy chest stays should be provided.

Great care should be taken in finishing the chest. The cedar is always left in the natural color and requires merely to be varnished. If the mahogany is of a dark variety, it also can be left in the natural color, but ordinarily it should be stained either by applying a mahogany stain before filling or by using a mahogany filler.

If natural colored paste filler is darkened with burnt sienna, the result will usually give a brown mahogany color that looks well. If an antique mahogany finish is desired, the wood can be stained before filling with a solution of ¼ oz. of potassium



Details of chest shown at the right

bichromate in 1 pt. of hot water, applied cold. In any case, the mahogany should be filled with paste filler.

Additional working details and bill of materials for this chest are contained in Home Workshop Blueprint No. 17 and will be sent anywhere for 25 cents to cover the cost of blueprinting and handling.

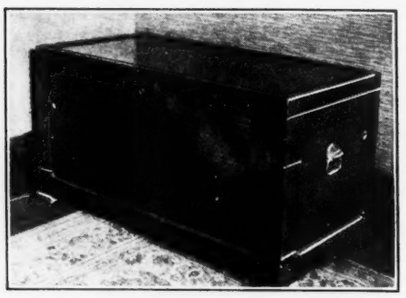
One advantage in building a chest is that it can be designed to suit the space available. Sometimes commercial chests are too long or do not, in the smaller sizes, have sufficient capacity. It was to overcome objections of this sort E. E. Scott of Pittsfield, Mass., designed and built the chest illustrated above.

The lumber required is 26 board feet of ⅞-in. stock and 30 linear feet of ⅜ by 2½-in. stock. The material is cut roughly to size and tongued and grooved at the mill for a small extra charge. The corners are not dovetailed, the trim serving to cover up the screws that hold the joints together.

The first step is to match up the boards for the bottom, glue and clamp them together and, after the glue is dry, to cut out a rectangle 35¼ in. by 17¾ in. The sides and ends are then built up, all being joined at the corners with 2½-in. screws, countersunk. The corners are reinforced inside with 1-in. quarter round molding.

The trim is then cut and fitted. The corner joints in this case are mitered and the trim is attached with liquid glue and 1-in. brads, the heads of which are cut off with pliers before the brads are set; then, when driven in, they do not leave large holes to be filled in finishing.

Three stout brass hinges are used for hingeing the cover and two chains provided to prevent its falling backward. A brass lock and handles are put on after the chest is varnished. A sliding tray 4 in. deep and 1 ft. shorter than the chest is provided. It can be covered with cretonne.

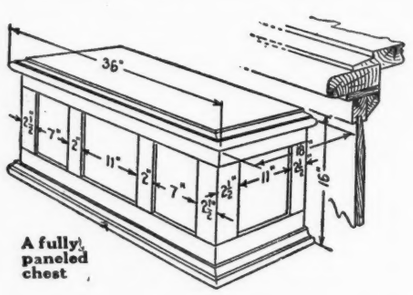


A neat and substantial homemade chest built according to details at the left

The finish is three coats of varnish, each sandpapered, followed by a final coat that should be sanded and rubbed with No. 0 steel wool, and polished with powdered pumice stone and oil. It then should be rubbed with curly horsehair.

Usually the inside shows the bare wood, but a good cretonne could be used in this case to conceal the wood and the fabric quickly becomes saturated with the delicate red cedar odor. This adds a distinctive feature not found in purchased chests.

Two of many styles of chests made entirely of cedar are shown in the small illustrations on page 78. These are finished in the natural wood and are ornamented with copper bands. Sizes that seem to be the most popular are 15 in. high, 19 in. wide, and 35, 40, or 44 in. long, and 17 in. high, 21 in. wide, and 48 in. long.



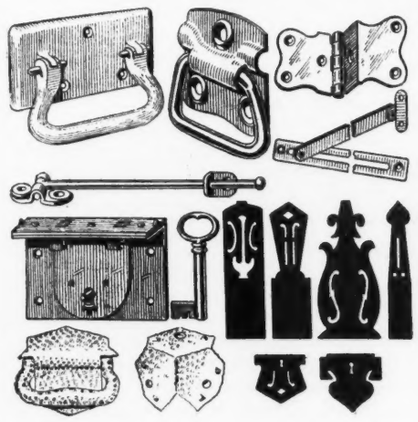
A fully paneled chest

The chest illustrated above is not so frequently seen. The sides and ends are paneled, the rails and stiles being ⅞-in. stock and the panels ½ in. The box itself is 36 in. long, 16 in. wide, and 16 in. high, the lid and base extending 1 in. beyond the sides and ends.

Hardware and trimmings for chests are shown in the illustrations on page 101. The larger handles have plates about 2½

by 5½ in. They are made in copper finish, brass, and bronze.

One leaf of a chest hinge is offset ¾ in. so that it bears against both the edge and the inside surface of the back of the chest. In some of the finer chests a continuous or "piano" hinge is used; this was the case in the original model of the "blueprint" chest. Stays and supports are made in both the styles illustrated and range from 6 to 14 in.



in length. Locks also vary in size, workmanship, and finish.

Thin gage copper bands for trimming chests can be obtained in various sizes, the most common being 2 or 4 in. wide, 11, 14, 22, and 28 in. long. Most of these bands have a satin finish and are lacquered to prevent tarnishing. Fancy designs are also frequently used. The one illustrated with the *f* openings is intended to be bent around chest corners. The two escutcheons are stock designs, but it is a simple matter to cut original designs from the plain strips. Copperized nails are used ordinarily for attaching the strips. Trimmings in imitation of old hammered copper are also manufactured. All these supplies can be obtained through hardware dealers or manual training supply companies.

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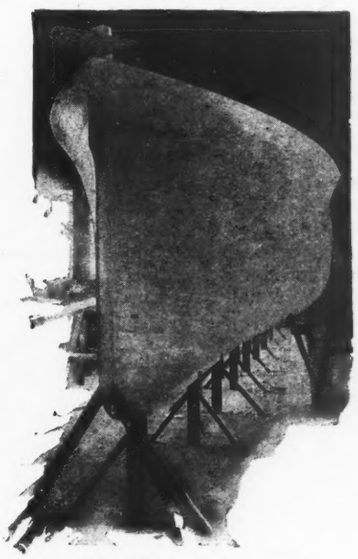

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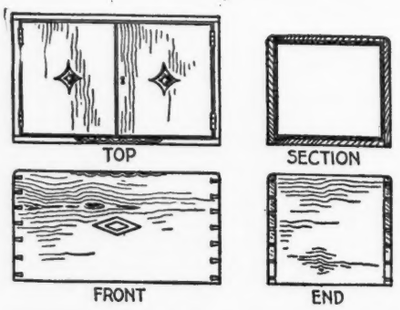
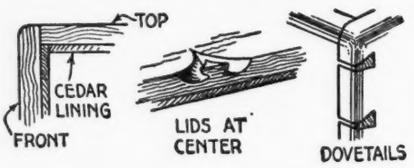
Cedar Lined Chest Has Double Lids

THE feature of this neat and craftsmanlike cedar-lined chest is two doors or lids that take the place of a large cumbersome one. These lids have the usual halved joint with a small bead on the edge where they meet at the center. The diamond in the center of each lid is carved to form a recess, as shown. This gives a grip by which to lift the lids without the necessity of using a handle that projects above the top. Flush brass ring pulls may be used instead, and if handles are desired at the ends of the chest, it is well to use flush chest handles, which can be obtained in various designs and finishes.





The outside of this chest may be made of any wood, only the lining being of red cedar. The general design is shown above and the details appear at the left

The chest proper may be made of any ⅞-in. wood available. The lining is of cedar, ⅜ in. or thinner. Even cigar box wood will do, if no other can conveniently be obtained. The size of the chest shown is 17 by 17 in. by 2 ft. 9 in. This is a medium size chest and for a larger one the dimensions might be 17 in. high, 20 in. wide and 3 ft. long.

Dovetail joints are used at the corners because a fine dovetail is always the sign of good workmanship and needs no embellishment and projecting moldings to enhance its value. Many hand dovetails and all machine dovetails are very much coarser than those shown, but for the best results these proportions should be followed. If it is not desired to go to so much trouble, a simpler type of joint may be substituted.

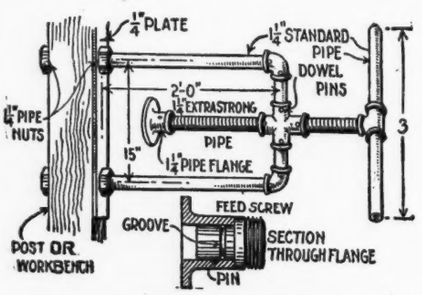
Feet can readily be added and they may either be carved or plain blocks about 4 in. square with the edges slightly rounded and projecting ½ in. Screw the feet from underneath to the bottom of the chest at the corners.—A. E.

Pipe Fittings Form Powerful Press

A CLAMPING, gripping and pressing fixture of ample size is a valuable addition to the home workshop. It saves straining the vise jaws, takes work that cannot be accommodated in the ordinary vise and does away with the necessity of improvising clamps.

The fixture illustrated is made up entirely of pipe fittings and can quickly be put together by any mechanic who possesses pipe cutters and threading dies. It is attached to a vertical post or to the bench, if preferred. Two similar clamps on adjacent posts are useful when long stock is to be handled.

A reinforcement of either ¼-in. steel or iron plate is essential under the clamp. The two pipe columns pass through the holes bored in the post and are secured by nuts on either face. They support a cross member that is connected to them by means of elbows and has a cross pipe connection in the center. Threaded into this is the feed screw, the upper end of which terminates in a pipe tee and two lengths of pipe to serve as the handle. The opposite end of the screw is fitted with a loose pipe flange secured with a pin.



A rugged, cheaply made fixture of wide utility in the small shop

Variations from the sizes indicated may be made, and smaller or larger pipe and connections may be substituted. The joints are treated with red or white lead and secured with drive-fit dowels.—S. N.

"Best Idea" Prizes Awarded for March

AS A bonus for the "Best Idea" articles contributed to the March Home Workshop, the following awards are made:

FIRST PRIZE, $15: Gladstone Califf, Richland, Iowa, "How to Remodel Old Furniture Profitably" (see page 104).

SECOND PRIZE, $10: A. M. Smyth, Germantown, Pa., "Papering Ceilings" (see page 132).

Both of the prize-winning articles contain exceedingly helpful suggestions for the home worker. Mr. Califf shows that it is rarely necessary to throw away an old piece of furniture. No matter how "second hand" it may be, the handy worker can refinish it so that it will be both useful and attractive, as proved by illustrations accompanying the article.

As for the paperhanging suggestions in Mr. Smyth's article, if followed carefully, they will insure success in the one task that holds the most terrors for the home decorator—papering ceilings.

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This battery is the product of the oldest and largest national distributor of radio, also makers of the line of famous Red Seal batteries for over 30 years.

The Red Seal Sparker—steel clad

ANOTHER step forward in battery building is the new Red Seal Sparker—steel clad—developed in the Manhattan laboratories.

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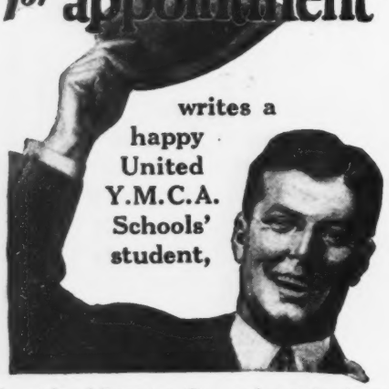

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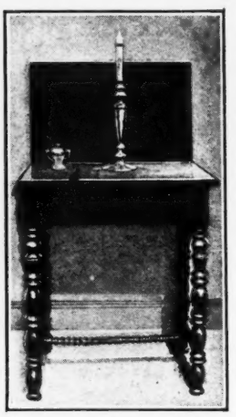
How to Remodel Old Furniture Profitably

By Gladstone Califf

IS THERE an old table in your attic that might be refinished, or a bureau of your grandmother that could be remodeled into a writing desk, or an old walnut breakfast table with a warped top that might be transformed into a dressing table? If so, why not undertake the work now, when the evenings are long and your home workshop is particularly inviting? You can do all sorts of miracles in the way of remodeling and refinishing old pieces, as I know from my own experience.

Almost every family has old pieces of furniture that belong to the past and are cherished only for their associations. These possess little value from the viewpoint of a secondhand dealer, but often can be given considerable actual value by a little work with tools and brush.

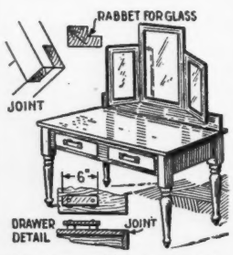


Card table made from discarded walnut bed

Suppose you have an old walnut table with a good top and two drop leaves, as I had. You can do many things with it, and one is to make a dressing table. Pick out the side that has the best appearance and cut out openings for the drawers in the rail. Make the drawers to fit, being sure to get them square and true. This work is not difficult, especially if you are lucky enough to have a combination plane. The sides and bottom of the drawers can be made of soft wood, such as cypress.

Drop Leaves Make Mirror Frames

The mirror rest is a straight piece of walnut; the frames are material from the drop leaves, the corners being fastened with halved joints. The glass fits into rabbets cut in the back of the frames. The center frame is stationary and the two side ones are hinged to it with loose pin butt hinges. The glass is dropped into the rabbet, a piece of heavy paper is laid over it, and it is fastened in place with brads driven into the frame at an angle. A piece of wallboard is nailed to the back of each frame with round brass upholstery nails or escutcheon pins. The drawer pulls are wood to match the table, although commercial knobs finished in dull bronze or other finishes can be used, if preferred.



Walnut table converted into dressing table

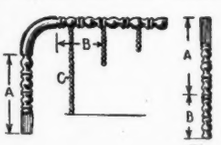
Perhaps the table you have is a little larger or smaller; you can use your own judgment as to dimensions. If you run out of wood, you can find what you want at a lumber yard, except perhaps some of the finer hard woods, such as walnut, but even then the lumber dealer will get it for you or you can buy it by mail from one of the large firms specializing in lumber for manual training classes.

An old washstand or a very small table can be converted into a dressing table by using the ends as they are and mortising longer rails at the front and back. The washstand drawer, if there was one, will probably serve for the dressing table.

Perhaps you have a discarded bedstead of some kind; it offers many opportunities. I converted an old fashioned walnut bed known as a Jenny Lind bed, into the card table illustrated. The table has a double top. The half that ordinarily stands against the wall can be let down and the whole top revolved so that the hinged joint runs across the frame, and both halves are supported squarely and centrally over the frame. The top is square when opened to its full extent. The proper place for the pivot can be found by trial.

The legs were made by sawing off the parts marked *A*, *B*, and *C*. Each pair of parts *A* and *B* was joined together with a dowel. Some work was saved because the lower part of *A* was already mortised. The sides of the bed provided material for the sides and ends of the table. The leaves from an old table were used for the top.

Another old table made the fern stand illustrated; in fact, it is simply the table without the top, the end rails being cut down to give the desired width. A narrow strip of wood nailed on top of the rails provides a ledge for the rim of the metal lining. This copper or galvanized iron lining can either be made at home or ordered from a tin shop.



The attractiveness of the fern box is enhanced if a bird cage is hung over it. If possible, make and finish the bird cage of material to match the table and support it from an arm screwed to the back of the stand. Hinge the door of the cage and provide a small metal sand and gravel tray to slip into the cage through a slot at one side.

An old fashioned cupboard of walnut lent itself readily to being remodeled into a china closet, although it could just as well have been made a most attractive bookcase. This particular cupboard had tin panels in the sides and doors; these were replaced with wooden panels in the sides and with leaded glass in the doors.

Old table adapted as fern stand

Another table provided the material for a piano bench. This is a simple matter and calls for the making of only two mortise and tenon joints. The legs are two pieces glued and nailed together, the heads of the nails being set and the holes filled with sawdust and glue. An old fashioned clock case was turned into a fine medicine chest.

In refinishing such pieces as these, the

(*Continued on page 106*)

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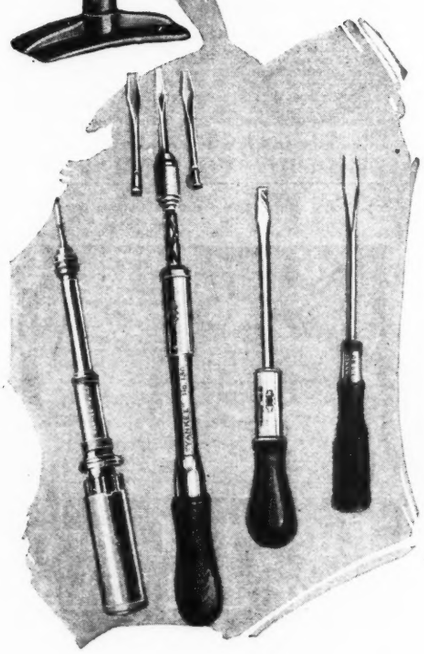

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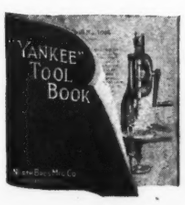

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WRITE for Free catalog of MONARCH Lathes, which are built up to 30" swing.

THE MONARCH MACHINE TOOL CO.
401 Oak Street SYDNEY, Ohio

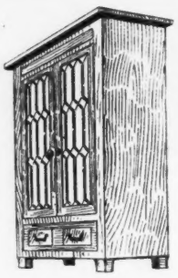
THE HOME WORKSHOP

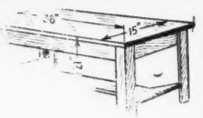
Remodeling Old Furniture

(*Continued from page 104*)

first step is to remove the old finish and sandpaper the surface smooth. Any pieces of new wood should be scraped with a cabinet scraper before sanding. Where staining is necessary, a good acid or water stain can be used, but before applying it, a sponge dipped in hot water is rubbed over the wood to raise the grain.

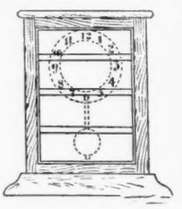
The stain is followed by a thin coat of shellac, which, when dry, is sandpapered





The bookcase with leaded glass doors, shown at the left, was made from a discarded cupboard. The piano bench below, which is another reclaimed piece, has a music compartment beneath the top

with fine and well worn sandpaper. The sanding smooths the grain previously raised by application of water. Wood filler is next applied with a brush and when it begins to lose its gloss, wiped off across the grain. Allow it to harden overnight. The filler should be the same color as the stain; for parts not stained, natural filler is used. One or two coats of shellac are then applied, and each rubbed with sandpaper.



An old-fashioned kitchen clock made into a medicine cabinet

The next step is to apply three coats of a good grade of varnish. This must be done in a warm room, free from dust. The last coat is rubbed with pumice stone and water, rottenstone and water, and finally rottenstone and oil, for a polished finish, and simply rubbed with pumice stone and water for a dull finish.

A variation in the method of finishing is to apply several coats of shellac, smoothing out each coat, and finish with two coats of wax, polishing them with a silk cloth. This makes a fine finish for walnut and has the advantage that it can be renewed easily from time to time. This is the finish used for the dressing table.

Furniture Features for April

AMONG the exceptionally helpful furniture articles in the April Home Workshop will be one on how to build a grandfather's clock, with designs for clocks ranging in value from $15 to $500.

Others will describe the construction of an inexpensive flat top desk, a girl's cabinet and writing desk, and a Colonial writing desk.

Unusual hints on finishing will be found in "Secrets of Making Realistic 'Antique' Furniture."

This describes in detail the little known tricks by which the home worker can duplicate the antique furniture finishes now so popular.

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See page 6 in front of book for full details

THE HOME WORKSHOP

Painting Kit Keeps Materials Handy for Odd Jobs

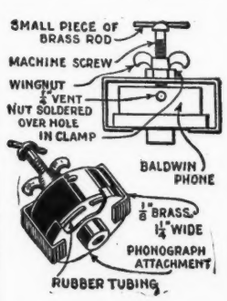
TO MAKE easier the innumerable painting, enameling, and varnishing jobs that constantly arise in every home, a painting kit can be made from any stout box of good size. It should have two hanging plates, so that it can be hung on the wall in

the cellar, garage, or workshop, and a handle for carrying it from place to place.

The interior is fitted with small compartments for holding cans of paint, putty, wax, turpentine, oil, and the like, and hooks for the brushes, scraper, putty knife, tack hammer, glass cutter, and other tools. This assures all the material being available when needed. The box also serves as a step in the absence of a ladder.—G. A.

Simple Adjustment Improves Homemade Loudspeaker

RADIO fans who use the Baldwin type C telephone in connection with a horn as a loudspeaker may have felt the need, as did the writer, for some method of adjusting the diaphragm so that the modulation and volume of tone can be regulated. To accomplish this the device illustrated, which cost about $1, has proved satisfactory. Speaking and singing come in clearly and naturally and band music has a good tonal quality that can be made low and mellow or loud and brilliant, as desired, by a slight turn of the adjusting screw.



The first step is to bore a ¼-in. hole in the rubber casing, as shown, to relieve the air cushion behind the diaphragm. A strip of ⅛-in. brass 1¼ in. wide is bent to form a clamp and has a nut soldered over a hole in the center to take a bolt with a wingnut. A piece of brass rod or a nail is soldered to the bolthead as a handle.

This clamp is used to hold against the telephone one of the rubber caps sold by radio dealers for connecting phones with a horn or phonograph. The threads on the inside of the cap should be removed so that it will fit easily over the phone. A length of small rubber tubing should be obtained at a drugstore to serve as a gasket between the cap and the phone when assembling the attachment. Adjustments are made by increasing or decreasing the pressure of the clamp.—JOHN A. MAHON.

The Bell System's transcontinental telephone line crossing Nevada

Highways of Speech

Necessity made the United States a nation of pioneers. Development came to us only by conquering the wilderness. For a hundred and fifty years we have been clearing farms and rearing communities where desolation was—bridging rivers and making roads—reaching out, step by step, to civilize three million square miles of country. One of the results has been the scattering of families in many places—the separation of parents and children, of brother and brother, by great distances.

To-day, millions of us live and make our success in places far from those where we were born, and even those of us who have remained in one place have relatives and friends who are scattered in other parts.

Again, business and industry have done what families have done—they have spread to many places and made connections in still other places.

Obviously, this has promoted a national community of every-day interest which characterizes no other nation in the world. It has given the people of the whole country the same kind, if not the same degree, of interest in one another as the people of a single city have. It has made necessary facilities of national communication which keep us in touch with the whole country and not just our own part of it.

The only telephone service which can fully serve the needs of the nation is one which brings all of the people within sound of one another's voices.

"BELL SYSTEM"
AMERICAN TELEPHONE AND TELEGRAPH COMPANY
AND ASSOCIATED COMPANIES

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Start your own moneymaking battery charging business NOW. No experience needed to make big steady profits with HB 8-hour Battery Charging. Universal demand, low operating cost.

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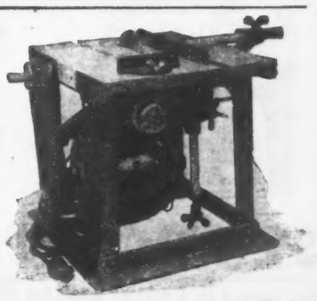
What You Can Do With this Boice Bench Saw

Boice-Built Bench Saw Model 140, illustrated here, provides a convenient, speedy, and economical way of doing hundreds of jobs requiring power and precision. Does cross-cutting, ripping, mitering, and grooving, with ease and accuracy. Special attachments enable machine to do grinding, sanding, drilling and dadoing.

Saws 7" dia. cut 2⅜" stock. Dado head 5" dia. cuts grooves 1⅛" deep x ⅝" wide, maximum. Screw adjustment elevates table for exact depth of cut. Machine will also cut brass, copper, bakelite, tubing, rods, carbon, and many similar materials. Motor ½ h. p. ball-bearing. Sold on a positive Money-Back Guarantee.



Write today for circular and prices on this machine, and also on Boice Junior Bench Saw, 4" Jointer, 14" Bench Band Saw, Motors and larger bench saw

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None of the automobile's winter troubles bother the Harley - Davidson rider. His husky mount gives him full mastery over all road conditions, winter and summer — the same eager power, the same tremendous burst of speed, the same rushing get-away.

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See page 6 in front of book for full details

THE HOME WORKSHOP

Tools for the Home Workshop

(*Continued from page 77*)

be held firmly and securely on a solid bed.

For very fine work, the cap iron should be set very close to the edge of the cutting iron. For coarse work, the cap iron can be set back as far as ⅛ in. The bevel of plane cutters is at an angle of 25 degrees, as at *B*, Fig. 1, page 77. Approximately speaking, the bevel is twice as long as the cutter is thick. If the bevel is too short, the plane will not cut well, and if it is too long, the plane will jump and chatter.

In sharpening a cutter on the oilstone, avoid the common fault of making a short bevel, as at *C*, Fig. 1. Keep your hand down when rubbing on the stone to make a long bevel, thus obtaining a keen cutting edge. It goes almost without saying that in sharpening a smooth plane, fore plane, or jointer, only the corners of the iron are slightly rounded, as at *E*, Fig. 1, whereas the iron of a jack plane for rough work may have a slight curve, as at *D*, Fig. 1. Rabbet planes, like chisels, are perfectly square with sharp corners, as at *F*.

The pitch or angle of the iron in the plane varies according to the work that is to be done, and ranges all the way from about 80 degrees, as in tooth planes used for scraping surfaces in preparation for laying veneers, to 12 degrees in the case of some of the modern low angle block planes. In one case the action approaches scraping and in the other, shaving. For fine work, especially dressing cross grained or gnarled surfaces of hard wood, and for use with a shooting board in planing miters, a plane with a low angle cutter is useful.

The woodworker has, indeed, a wide range of choice in selecting fine planes and can get many varieties for special work, such as edge trimming planes, bullnose planes, cabinetmaker's edge planes, not to speak of universal plow and matching planes and molding planes.

Tricks in Sharpening Saws

Sharpening saws involves no more difficulty than sharpening planes when once the principles have been learned. A new saw is properly set and sharpened, so that all the woodworker has to do is to preserve the teeth in the same shape and condition as when new, so far as possible. Therefore, never let a saw get into bad shape before re-sharpening.

The teeth should first be "jointed" or made even in length by running over them a flat file held by hand or in a saw jointer, as at *A*, Fig. 2. This is not necessary every time the saw is filed, but should be done when the teeth have become noticeably uneven. Next, the teeth are set, although this is sometimes done before top jointing. Various saw sets can be obtained for this purpose. The points are bent alternately right and left, as in the original setting, and it is important not to set the teeth too far into the saw. In other words, give the teeth as little set as will serve. Fine saws, such as panel, dovetail, and tenon saws, sometimes are not set at all, the taper of the blade giving sufficient clearance. Begin at one end of the saw and set every other tooth. Then reverse the saw and set the remaining teeth. If the setting has been done unevenly, file the teeth edges on the side with a mill file.

The files to be used for sharpening are

(*Continued on page 110*)

RADIO

$15 Down $10.00 a Month

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Regenerative RADIO Receiving Set

Built by Tri City Radio Electric Co. (Licensed under U. S. Patent No. 1,113,149 and pending letters Patent No. 807,388.)

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"Sensitone" Set is complete—including batteries, tubes, head-phone, antenna, wiring - connections — **everything you need,** ready to install, is equal to sets now sold at $150.00 to $175.00, yet our price is only $95.00.

Set is shipped on receipt of the first $15.00 payment. You are dealing with a responsible, old-established House. Ask any banker or business man to look up our rating in Dun or Bradstreet Reports.

Only a limited number of "Sensitone" sets will be sold on this easy-pay plan. Fill out coupon and attach check or money order for $15.00. Circular **free.**

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836 W. Washington St., Chicago, Ill.

Enclosed you will find $15.00 as first payment, upon receipt of which you will send me your complete Sensitone Radio Receiving Set, as described above. I agree to send you $10.00 every thirty days thereafter, until the full purchase price is paid. This set is to remain the property of Harold R. Wakem & Co., until payments are completed.

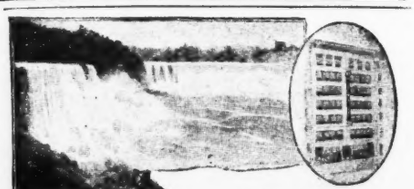
Signed .....

Street address..... City.....

In the spaces below give the names of two references, banks or business houses preferred.

Name and Address .....

Name and Address .....



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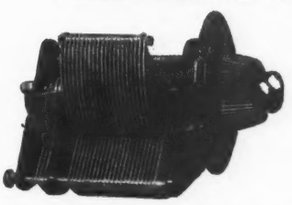
No. **69C** Head Set 2000 ohms.....each, **8.00**
No. **74A** Head Set 1000 ohms.....each, **5.00**

VARIABLE CONDENSERS



Decremeter type 11, 23, and 43 plate with and without vernier. Standard capacities. With this variable condenser the dial scale can be correctly calibrated. The amount of increase or decrease of the plate surface variation is always constant.

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All Bakelite. Non-warping, reinforced construction. 5/16" shaft with bushings for ¼" and 3/16" shafts included.

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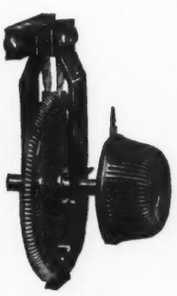
RHEOSTATS



No. 501

The Kellogg rheostat is simple in design, having but one movable part. The resistance wire is carried on a rotor of high grade insulating material and the contact arms are so placed that a slight movement brings in the one-half turn of the wire, giving a vernier effect. The knob is the same type and size as the Kellogg dial.

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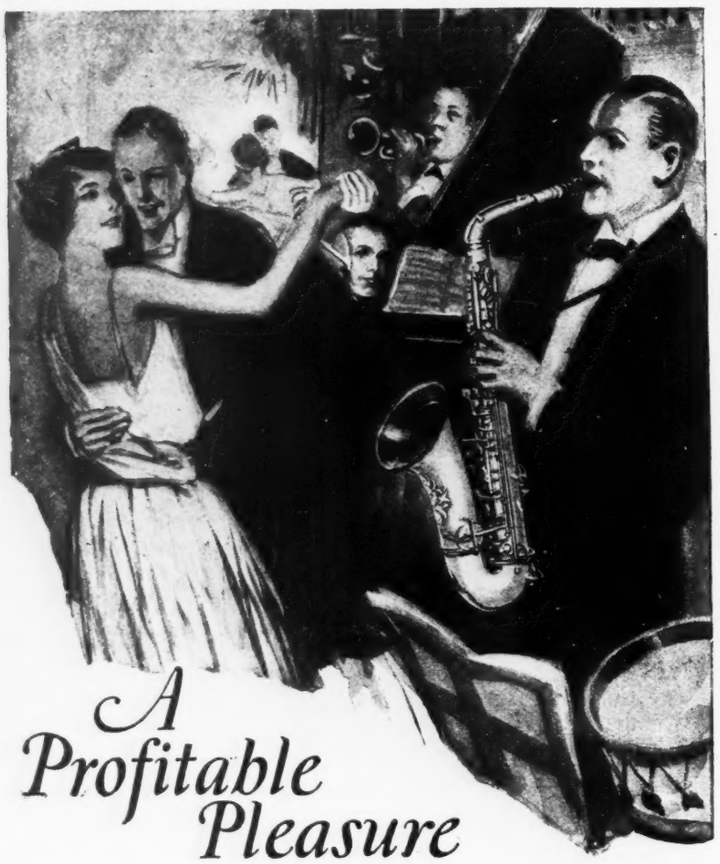
No. **501** Variometer..... **$8.00**

All Kellogg Radio equipment is of the same high standard and is guaranteed by Kellogg — USE, IS THE TEST

KELLOGG SWITCHBOARD & SUPPLY CO., CHICAGO



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WORLD'S LARGEST MANUFACTURERS OF HIGH GRADE BAND AND ORCHESTRA INSTRUMENTS

CULTIVATE YOUR MUSICAL BUMP

THE HOME WORKSHOP

Tools for the Home Workshop

(*Continued from page 108*)

generally a 7-in. slim taper file for a 5, 6, or 7 pt. saw, a 6-in. slim taper file for a 8 or 9 pt. saw, and a 5-in. slim taper file for a 10, 11, or 12 pt. saw.

Clamp the saw in a saw vise with the point or toe at the left and, beginning at the left, file alternate teeth the entire length of the blade. Place the file well into the gullet at about the angle at which the teeth originally were filed, and see that the tooth that is set toward the other side of the saw is on the right side of the file. The position of the file on the teeth of a crosscut and rip saw is shown at *B* and *C*, Fig. 2. The file can be either held level, as at *F*, or tilted up, as at *G*. The latter angle is more difficult to maintain unless an adjustable vise is used, in which case the whole saw can be tilted so that the file itself may still be held level. The difference in the resulting shape of the teeth is indicated at *D* and *E*.

Ordinarily the point of the file is pointed a trifle toward the point of the saw, although a ripsaw for general work can be filed straight across. The exact angle at which the file should point back is quickly learned by experience and varies with the sort of work that is to be done. Some mechanics, however, will tell you that the file should point toward the handle and, as a matter of fact, opinions differ, but if the file is pointed toward the handle, the point of the file must be tilted up as shown in the oblique position at *G*. When the saw is reversed to file from the other side, the same angles are maintained, only now the teeth that are set away are on the left of the file. The final step (*H*) is to pass a hard oilstone over the sides of the teeth lightly once or twice to remove any wire edges produced in filing.

Protecting Tools from Rust

The best protection for tools that I have found is to pass a rag saturated with good lubricating oil over all the saws, chisels, planes, and bits now and then. If this is done over both wood and steel every two or three weeks, the tools will look almost like new after years of service. If the steel should get damp with rain or otherwise, a piece of very fine sandpaper or fine pumice stone powder should be rubbed on with some oil. When tools are to be put away for some time, it is advisable to mix a little vaseline with the oil, to give it a greater body, and cover the steel parts liberally.

If dampproof drawers or closets are not available, a carpenter's "shoulder box" is a good substitute. By getting into the habit of slipping the tools into their individual racks or places every time one gets through using them, and if the oil rubs are not omitted, the tools can be kept in good shape even in a damp place. Boxes arranged to receive complete working sets of tools are now made at such reasonable prices that even mechanics prefer to buy rather than to make them. Bits, fine chisels, and gouges are done up in cloth rolls with pockets for each tool. These usually come with complete sets of tools, but they can easily be made at home.

When you strike a nail with a bit, restore the edge with an auger bit file or a fine warding file. Keep to the angle in which the bit was formed and never file on the outside. Do not file any more than is ab-

(*Continued on page 112*)

You can now obtain *Condensite Celoron Radio Panels* cut in standard sizes

You can now get radio panels already cut to a size to fit your needs. For your convenience we are making Condensite Celoron Radio Panels in seven standard sizes. No longer will you have to wait and pay extra cost for having your panel cut to order.

These sizes have been so designed as to meet practically every need of the set-builder. Each panel comes trimmed and wrapped separately in glassine paper to protect the surface. They are all ready for immediate use. On every one are full instructions for working and finishing.

What Condensite Celoron is

Condensite Celoron is a laminated phenolic condensation product used by many of the leading manufacturers of radio equipment. It has high insulation resistance, high dielectric strength, low dielectric losses and is easily worked. Because Celoron has these qualities it has received the approval of the U. S. Navy Department, Bureau of Engineering and the U. S. Signal Corps.

You can obtain any of these seven standard sizes:

1. 6x 7x1/8
2. 7x 9x1/8
3. 7x12x1/8
4. 7x18x3/16
5. 9x14x3/16
6. 7x21x3/16
7. 12x14x3/16

Select the size you need for your set. If your radio dealer has not yet stocked them, ask him to order for you. Or write direct to us, designating by number the size you want. We can make prompt shipment.

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No books or useless theory. You are trained on $100,000 worth of electrical equipment. Everything from door bells to power plants. You work on motors, generators, house-wiring, autos, batteries, radio, switch-boards, power plants—everything to make you an expert ready to step right into a position paying from $45 to $100 a week.

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THE HOME WORKSHOP

Tools for the Home Workshop

(*Continued from page 110*)

solutely necessary or the bit will soon be useless.

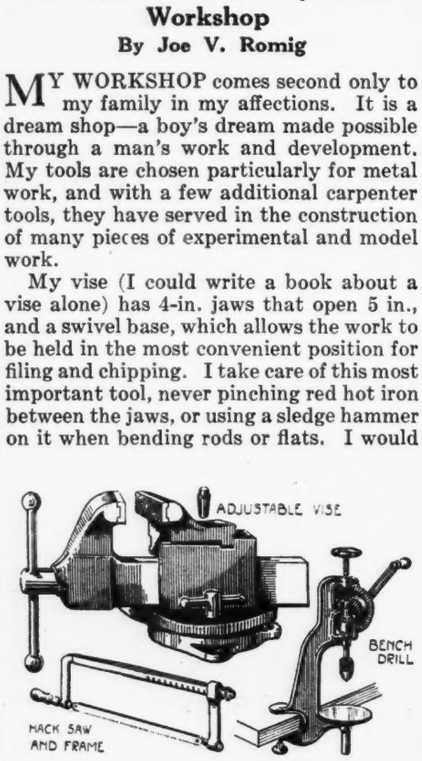
I have often been surprised that amateur woodworkers do not make more use of hand screws. They can be put to innumerable uses and serve to increase one's thumbs and fingers. At least two good iron woodworker's clamps will be found invaluable at times for holding material when working it or gluing it up, especially if any furniture making is done in the home workshop.

The Tools I Use in My Home Workshop

By Joe V. Romig

MY WORKSHOP comes second only to my family in my affections. It is a dream shop—a boy's dream made possible through a man's work and development. My tools are chosen particularly for metal work, and with a few additional carpenter tools, they have served in the construction of many pieces of experimental and model work.

My vise (I could write a book about a vise alone) has 4-in. jaws that open 5 in., and a swivel base, which allows the work to be held in the most convenient position for filing and chipping. I take care of this most important tool, never pinching red hot iron between the jaws, or using a sledge hammer on it when bending rods or flats. I would not permit my best friend to straighten a piece of steel on the flat of the slide. In buying a vise, I should always give preference to one with set-in steel jaws; this adds to the cost, but makes it possible to put in new jaws when the old play out.



The style of vise, bench drill and hacksaw used by Mr. Romig

My bench drill I chose with a view of practicability, and it holds drills from 0 to ⅜ in. It is equipped with drill pad and chuck. In order to lighten the strains of drilling large holes, I always drill a small lead hole first. I keep the tool well oiled and never try to make a punch press out of it by using a dull drill.

My hammers are many, three machinist ball peins, 1½, 1¼, and 1 lb., a pattern maker's hammer of medium size, a 2-lb. sledge hammer, and an assortment of small ball and straight pein hammers, from a few ounces up to half a pound. Included in my lot of hammers I must mention two wooden mauls, as well as a brass and a lead ham-

(*Continued on page 113*)

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It's Easy with Landon Picture Charts

If you like to draw—develop your ability and become a successful cartoonist. Get the same instruction—the same help that has developed so many of the successful cartoonists of today.

Hundreds of nationally known cartoonists—young fellows such as Branner of the Chicago Tribune; Blosser, who draws "Freckles and His Friends"; Gene Byrnes, creator of "Reg'lar Fellers"; Dorman Smith of the N. E. A. Service; Thiele of Sioux City Tribune, and scores of others equally famous developed their ability, at home, through the famous

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THE HOME WORKSHOP

The Tools I Use

(*Continued from page 112*)

mer. It pays always to use a proper weight hammer for the work in hand. If a hammer head should prove too hard and chip off, I throw it away, as it is a dangerous tool to keep, and even if softened, it is already disfigured by the chipped face.

To get the best results out of a hammer, it must be fitted with a proper handle. Many hammers are bought with handles that remind me only of a stick of wood. By shaving a handle down to a thin section below the head, a snappier action is secured. To preserve the wood, I always give the handles several coats of shellac. Never use the hammer handle to bump or pound metal parts, as this will often cause the handle to crack or split; use a maul instead.

My set of chisels contains all shapes and sizes, from 1-16-in. cape to 1¼-in. straight cold chisels. Many of them I forge out of octagon chisel steel, and temper according to the use I intend to put them to. If I break off a corner of the cutting edge, I always throw the broken chisel into the redressing box, and when enough accumulate, I dress them all at one time.

My files, of which I have almost all of the ordinary shapes and sizes, are kept according to size in a partitioned tray. The larger sizes are kept on the bench, as they are used the most. Each file has its own handle, and is never used without it. I clean my files with a wire brush and soft pine wood wipers, and never pound them on metal.

Micrometers and Measuring Tools

My measuring tools consist of a 2-, 3-, and 6-in. rule, also a 12-in.combination set, the square and bevel protractors which have hardened and ground faces. A 50-ft. steel tape line, of known and guaranteed accuracy, is used for long measurements.

My micrometers are of 1-, 2-, and 3-in. sizes, and a set of 2- to 8-in. inside micrometers are used on internal work. A set of 3- and 6-in. dividers, together with a metal beam trammel set, serve for my layout work. I prefer spring calipers to the solid type, and I have them in 3-, 6-, and 12-in. sizes.

One of the handiest tools is the drill gage for measuring drills and wire rods. This tool also converts the drill size into thousandths of an inch. All small tools, such as screw and thickness gages, center punches, surface and depth gages, scrapers, and the like, are kept in a felt-lined tool box.

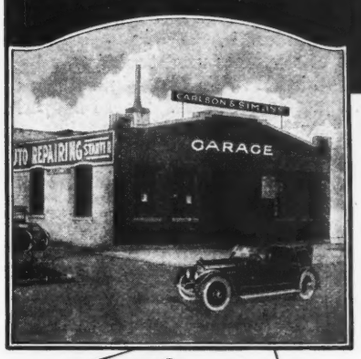
Oilstones of three different grits are kept in covered cases, to prevent dust from clogging their surfaces.

My taps and dies are kept in three boxes; the fine threads have a die of ¾-in. diameter, and the larger sets cut from ⅜ to ¼ and ¼ to ½ in. threads respectively. These sets have loose dies that can be replaced when worn out. I always try to keep at least two taps of each size on hand, so as to have one in reserve in case of breakage. My oil can is a close companion to all my thread-cutting tools, as oil makes for better threads and saves the taps and dies.

My hacksaw frames, of which I have two, take blades from 6 in. in length up to 12 in. The blades are chosen for the work in hand, and for general all around use, I prefer a medium fine toothed blade. For cutting brass bushings and iron pipe and tubes, I always use a fine tooth saw. Oil is good to

(*Continued on page 114*)

Auto Mechanic Makes $5200 Net Profit 1st Year



Unlimited Opportunities for Auto Mechanics

Here's an opportunity to go into business for yourself. Greer men are making good money—they get the pick of waiting positions and are successful. You have the same chance to succeed. Greer training will fit you in a few short weeks to take a position or start a business of your own, paying good money right from the start.

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About a year ago we graduated from the Greer School. Realizing the automobile business offered many splendid opportunities, we decided to go into business for ourselves. As our capital was limited, we were obliged to start on a small scale. Business came in right from the start. At the end of a year our net profit was $5,200. Our business has already outgrown our present quarters and we must seek a larger building.
(Signed) Carlson & Simon.

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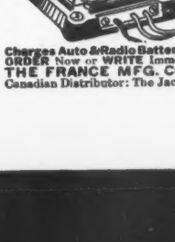

Type 6 charges A 6 Volt Battery At 6 amps $15
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THE FRANCE MFG. CO., CLEVELAND, OHIO, U. S. A.
Canadian Distributor: The Jack V. Elliot Co., Hamilton, Ontario, Canada.

A New Butter-Kist Popcorn Machine at Half Former Price!

HERE'S a marvelous money-making opportunity—a beautiful, new automatic Butter-Kist Popcorn Machine at *half* what former models cost.

For a small down-payment this new Gold Mine Model will be shipped immediately to any responsible retailer. Within a few hours after its receipt you can be earning big profits, selling the world-famous Butter-Kist Popcorn, out of which you should easily and quickly pay the balance.

The "Gold Mine" is a beauty. Attractive mahogany-finished cabinet. Handsome glass sides. Highly polished nickel parts. Takes up little room. Feeds, discharges, pops and butters the corn automatically. Keeps the corn warm and crisp after popping. Produces thirty 10-cent packages an hour.

Butter-Kist Popcorn sells fast. It's nationally known and advertised. People go out of their way to buy Butter-Kist. Out of every dollar's worth you sell, you keep 65 cents as *your* profit! F. J. Studer writes, "My Butter-Kist Popcorn profits have averaged over $900 per year for six years". R. C. Hoegge says, "First six months' sales went over $2500". Many are making even more.

The "Gold Mine" attracts customers. Builds trade. Makes big profits. Write immediately for the new Butter-Kist Easy Payment Plan.

Butter-Kist Popcorn
"America's Oldest Treat"

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World's Largest Manufacturers of Popcorn Machines and Peanut Toasters
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Please send me, without obligation on my part, your free Butter-Kist book. I also want the Location Chart which I will fill out and return to you.
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The coupon filled in, will give you a quick start towards big profits. No obligation on your part. Fill in and mail TODAY.

BUTTER-KIST
Popcorn and Peanut Machines

THE HOME WORKSHOP

The Tools I Use

(*Continued from page 113*)

use when sawing any of the harder metals, as it lessens breakage through cramped and wedged blades.

One of my most used tools is my bench plate, which is made of a 1-in. section of a 6-in. square steel billet. This I shaped on both sides. I use one side for rough work and the other for finished work and laying out. Once I caught a neighbor trying to straighten a nail on the good side of the plate, and I made him think he had committed an awful crime before I was through preaching to him about bench plates, their use and abuse.

Of wrenches and pliers I have a goodly number, of all shapes and sizes.

My carpenter tools consist of a fine toothback saw, a crosscut saw, an all iron block plane, smooth plane, wood chisels of many sizes, as well as gouges and carving tools. Ratchet brace and bits, expansion bits, a fretsaw, a turning saw for curved or circular sawing, a 10-in. pair of tin shears, together with a good husky blowtorch and soldering irons complete my outfit.

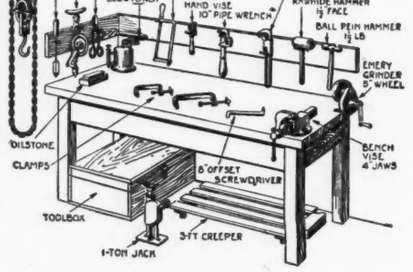
With these tools always kept sharp and in the pink of condition, I am ready at any time to build a new experimental model or repair the many mechanical contrivances that are found in the modern home.

How I Choose a Set of Tools for Repairing My Auto

By George A. Luers

IN SELECTING tools for my own tool roll and for my garage, I followed a definite plan that has proved satisfactory and economical. Starting at the radiator and working back to the rear axle, I examined each detail of the mechanism of my car to obtain a good idea of the fastenings, bearings, adjustments, packings, and working parts, and consequently of the tools necessary for making such repairs and adjustments as might be necessary. This study resulted in the selection of a kit of tools, so that I am now never handicapped in making repairs.

You may ask the result of this tool selection and care. Here is the answer: A thoroughly efficient car, free from roadside



The garage equipment used and recommended by Mr. Luers

trouble, ready at any time for any destination, and able to travel as fast as the law allows and sometimes faster.

My collection of tools is somewhat larger than the usual because it has been gathered over a long period and the purchases have really meant economy in that I have been

(*Continued on page 115*)

HOMCHARGE your RADIO BATTERY for A NICKEL

Enjoyable concerts and maximum receiving range are obtained only when your battery is fully charged.

THE HOMCHARGER

charges your "A" or "B" battery over night for a nickel without removing it from your living room. No muss—no trouble—no dirt—requires no watching.

After the concert connect to any lamp socket, snap the clips on your battery and "turn in." While you sleep the **Homcharger** is silently charging your battery, the charging rate being governed automatically. In the morning it is fully charged. No **other** battery charger can boast of such *quick* and *economical* performance.

The **Homcharger** is the only battery charger combining all of these **necessary Homcharging** features—**Self-polarizing**—**five** to **eight ampere** charging rate—**Underwriters' approval**—beautifully finished in mahogany and old gold—**unqualifiedly guaranteed.** Over **60,000 now in use.**

Sold complete with ammeter, etc., by all good radio and electrical dealers for $18.50 (**$25.00 in Canada**).

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LARGEST MANUFACTURERS OF VIBRATING RECTIFIERS IN THE WORLD

THE HOME WORKSHOP

Auto Repairing Tools

(*Continued from page 114*)

able to keep my car out of repair shops. The tools that I consider indispensable to the car owner who desires a collection of his own are indicated in bold face type in the list that follows:

FOR THE ENGINE:
Spark plug wrench
Spring compressor, adjustable
Valve grinder
2 open end valve adjusting wrenches
Main bearing socket wrench
Connecting rod socket wrench
Carbon scraper, 10 in.
Wire scratch brush, 12 in.
Contact file, 5 in.
2 contact adjusting wrenches

FOR WHEELS AND WHEEL BEARINGS:
Hub cap socket wrench
Bearing adjustment open end wrench
Rim bolt socket wrench
Wheel puller, screw type

FOR THE CLUTCH:
Clutch spring adjusting open end wrenches
Offset screwdriver, 6 in.

FOR THE TRANSMISSION:
Transmission bearing adjusting open end wrench and socket wrench

FOR THE UNIVERSAL JOINT:
Socket wrench
Open end wrench

FOR THE BRAKES:
Wingnut spanner wrench
Open end wrench

FOR THE DIFFERENTIAL:
2 differential adjusting spanners

FOR GENERAL PURPOSES:
Screwdrivers, 6 in. and 12 in.
Adjustable end wrench 8 in.
Ball pein hammer, ¾ lb.
Adjustable pliers, 5 in. and 7 in.
Set of double end wrenches to fit bolt sizes from 3/16 to ⅝ in.
Set of sockets with wrench handle for same sizes. (These are obtained least expensively in full sets.)
It should be noted that the spanners and large sockets may be obtained through the car agencies, as they are frequently special sizes.

For my garage tool equipment I have the following:

½-ton chain hoist
3-ft. creeper
1-ton jack
Bench vise, 4-in. jaws
Emery grinder, 5-in. wheel
Soldering copper, ¾ lb.
Breast drill, 18 in.
Tin snips, 8 in.
Blowtorch, 1-qt. size
Hacksaw, adjustable
Hand vise, 6 in.
Pipe wrench, 10 in.
Monkey wrench, 14 in.
Rawhide hammer, 1½-in. face
Ball pein hammer, 1½lb.
Screw pitch gage
Feeler gage
Firm joint calipers, inside and outside, 6 in.
Rule, English and metric, 2 ft., fourfold
Rule, steel, 6 in.
Octagon reamer, 6½ in.
Rose countersink
File, half round, 8 in.
File, 3-square, 6 in.
File, flat, bastard, 10 in.
File, square, bastard, 10 in.
Chisel, half round, ½-in. blade
Chisel, diamond point, 5/32-in. point
Chisel, cape, ⅜ in.
Chisel, cold, ½ in.
Solid punch, 5/32-in. point
Prick punch
Pin punches, 5/32 in. and ¼ in.
Center punch, ⅜ in.
Cotterpin puller
Tire tool
Tire chain tool
Bearing scraper, 8 in., 3 sq., hollow ground
Screwdriver, offset, 8 in.
Clamps, 4 and 8 in.
Oilstone

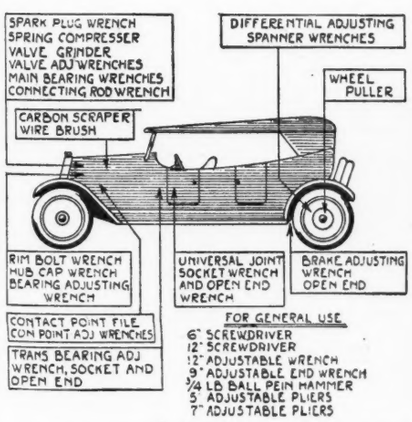

Diagram showing that each tool in Mr. Luers' kit has a specific use

It should never be forgotten that the automobile represents an extremely successful mechanical construction. The essen-

(*Continued on page 116*)

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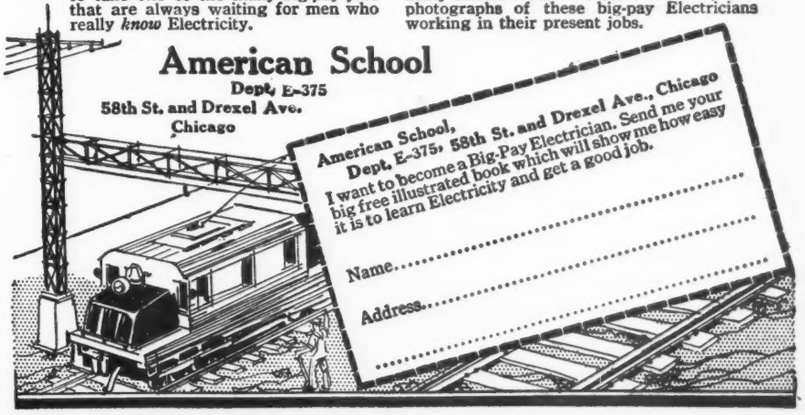

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THE HOME WORKSHOP

Auto-Repairing Tools

(*Continued from page 115*)

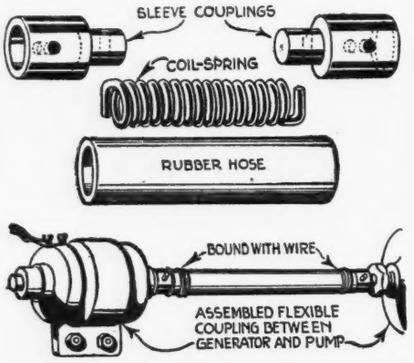
tials for its uninterrupted service are the maintenance, as far as possible, of its condition when new, with only such adjustments as are due to wear and the renewal of broken parts that have become crystallized through continued stress and vibration. Since the tool equipment is solely for the upkeep of the automobile, it should be selected with care and not guessed at.

Good care of the tools is essential. Each of my tools is placed in a definite location, either in the car or in the garage tool rack, and I am never at a loss to find it when needed. Each tool is carefully wiped of grease, grit and water, and is never abused. That is, a wrench is not used as a driver or a hammer to loosen screw parts. I take care to use wrenches that fit the flats of a bolt or nut, and never make an oversize wrench do, because that has a tendency to spring the jaws.

The edge tools are kept sharp, particularly the nose of the screwdriver. I never pound on wrench handles, and make it a practice to keep tools off the seats and off the painted surface of the car, and never throw them down. When a job is complete, I put the tools back in proper order and, therefore, automatically obtain a check on them to see that none has been overlooked.

Improvising a Generator Drive

THE flexible shaft drive shown in the accompanying drawing was used to turn a generator for the electrical system of an automobile on which a burned-out generator had been replaced by one that was too large to go into the bracket.



The former coupling had consisted of a circular disk held between two sleeve fasteners. The improvised coupling was made by riveting into two sleeves the ends of a heavy spring. Over this spring a section of rubber hose was placed. This drive compensated for lack of alinement of the parts and provided a serviceable coupling.—G.A.

Your Auto Tool Box

NEXT in importance to having a good kit of tools for your car is to have a convenient toolbox or compartment where they will be instantly accessible for road repairs. Several ideal arrangements for accomplishing this will be described in a forthcoming number by Harold F. Blanchard, POPULAR SCIENCE MONTHLY'S auto expert.

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To show you how easily and quickly you can learn his new way, Arthur Murray has consented to send, for but a limited time, a special course of sixteen dancing lessons for only $1.00. This extraordinary offer is made to prove you will enjoy learning the newest steps in the privacy of your own home—without onlookers to embarrass you. **You need not send any money now.** When the postman hands you the 16-lesson course, just deposit $1 with him, plus a few cents postage, in **full payment.** If within five days you are not delighted, return the lessons and your money will be promptly refunded.

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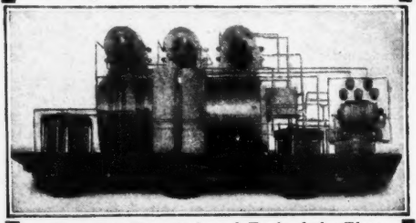

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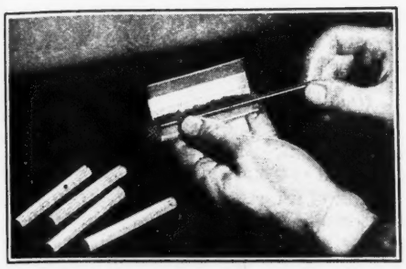
THE HOME WORKSHOP

Rolling "Your Own" with the Simplest Cigarette Machine

A SMALL piece of tracing cloth and a meat skewer are all that is necessary to make a cigarette rolling "machine." The device is amusingly simple and yet turns out cigarettes that are rolled as well as machine made "butts." The cigarettes can be made thin or thick, tight or loose at will.

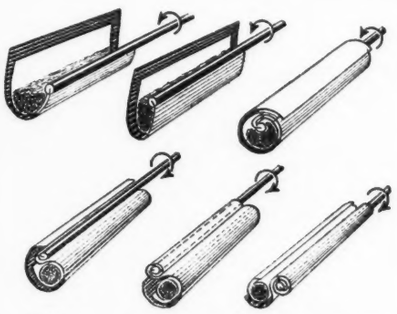
The skewer or other small wooden rod of about the same diameter is split in half for 3 in. from one end. In this split is glued one



How the tobacco and paper are placed in the "machine" when starting to roll

long edge of a piece of tracing cloth 2¼ by 3 in., so that the device somewhat resembles a miniature flag.

To roll a cigarette, the paper, preferably with a gummed edge, is placed on the tracing cloth and the tobacco is distributed evenly on it as if for hand rolling. The outside edge of the tracing cloth is brought over the stick so as to form a loose cylinder, with tobacco and paper inside and the end of the



Rolling a cigarette step by step. Paper and tobacco are placed on the tracing cloth and the handle is turned forward, as shown in the three upper views. Turning the handle backward then releases the cigarette

stick is then turned in the direction shown in the diagram until the cigarette is wrapped as tightly as desired.

Next, the handle is turned in the opposite direction while the fingers of the left hand control the movement and prevent the cigarette's loosening. This results in the tracing cloth being unwound from the cigarette, and it is then necessary only to stick down the edge of the paper.—R. S. G.

How You Can Make Two Remarkable Radio Sets

COMPLETE details of how to assemble a dry-cell regenerative vacuum tube set at a cost of $20 or less, including phones and aerial, will be given in the April Home Workshop.

Another feature will tell how to build a receiving set with three stages of audio frequency amplification that provides extraordinary tone volume and clearness on the loudspeaker.

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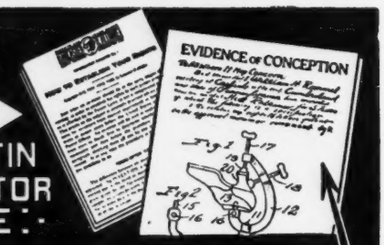

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Man and His World

(*Continued from page 30*)

In addition to these things that all protoplasm does, any particular variety of it usually has a lot of other things that it is able to do. For instance, nerve cells can produce and transmit nervous signals. The cells in the green leaves of plants can make sugar. One and the same cell—for instance, the cell of any one-celled creature—is often able to do 20 or 30 separate things at the same time.

Why is this? How can one little piece of living matter do all these different things—breathe, eat, grow, reproduce?

Scientists have not yet solved this mystery, but they are beginning to believe that it is because there exists inside of protoplasm a very complicated kind of structure, something like a group of tiny separate compartments. In these compartments the varied activities of the cell can go on separately and yet side by side.

Think of a factory in which automobiles are made. In it are many separate rooms where workmen hammer out the various metal parts or shape them or put them together. And imagine a giant so huge that this whole factory measures in comparison no more than a thousandth of an inch. This giant would never see the single rooms of the factory at all. He would see only the entire building. He would notice that it ate coal and iron and that it gave birth to little moving particles that ran about by themselves. But how all this was done he would not be able to guess.

Invisible Workshops of Life

Toward protoplasm all of us are giants. Its actions seem mysterious to us because we are not yet able to see into its separate workshops. When we learn to do so, we shall discover, scientists believe, that the things that go on in them are merely physical and chemical action, quite likes, the processes with which we are familiar.*

And meanwhile we can trace a good deal of the past history of living things. We begin with the little slime speck of the ancient tide pools, a speck not unlike the modern cell, but far simpler in its structure. From this speck we believe that life grew and diverged, through eons of time, into the plants and animals we know today.

What caused this divergence? It was caused by that fundamental law of life, the struggle for existence; the survival of the fittest; the rule that only the strong, the able, the inventive shall be allowed to live; the rule that in one form or another dominates the world and its inhabitants to this day.

This universal struggle for existence began even with the living slime specks in the primeval sea. In the beginning, all of these specks were dependent for food upon what was brought to them by the water in which they lived. Presumably this food consisted of chemicals of various kinds, things that Nature had made before she began to produce life itself. Now, as the number of the living specks increased, the supply of food in the water began to run short. This was the beginning of competition. Some of the specks—we would call them the stronger ones—began to get more than their share of food; others began to get less.

Then began what we know as effort.

* A few of these processes have been duplicated. For instance, Dr. Alexis Carrel, famous research worker of the Rockefeller Institute, has been able to keep living cells alive and growing for years outside the body from which they came. Dr. D. T. MacDougal, of the Carnegie Institution, has devised a piece of apparatus, illustrated on page 21 of this issue, which duplicates many of the actions of a living plant cell.

Man and His World

Some of the specks found that they could get more food by *trying* for it. They found it no longer advisable merely to drift about aimlessly, letting the water bring them whatever it happened to contain. And now the living specks made a fundamental decision, a decision that has affected the entire course of life since that day. Some of them made one decision; some made another. This was the first divergence, the first branching of the tree of life.

One group of the specks learned how to move. If there was not enough food where they happened to be, they learned to go somewhere else where food might be more plentiful. The specks of this group became animals. They discovered the spirit of adventure. They invented purpose and purposeful movement.

Another group of the specks took another road. They discovered that it was possible to manufacture their own food. They learned how to absorb sunlight, how to take up certain very simple chemicals, abundant in the water, and how to use the sunlight to convert these chemicals into food.

Plants—the World's Food Factories

These specks became plants. They still have this power of making food. Green plants still absorb sunlight in their leaves and they still use this, as we shall see in a later article, to manufacture food materials out of simple non-living chemicals. The green plants are the chemical food factories upon which all life depends.

For the primeval specks that decided to be plants, motion was unnecessary. Indeed, it might be a handicap. So these primeval plants learned to sit still. They developed rootlike projections that held them fast to the rocks.

This was the origin, we believe, of the first great distinction between the plant stem and the animal stem. Another distinction followed very soon. The animal cells, reproducing rapidly, began to grow short of food again.

Certain of their cousins, you remember, had settled down on the sea bottom near the shore where the light was good and had established food factories. They had become plants. The animal-like specks cast a greedy eye on these supplies of food. What more natural than that they should decide to steal it? They learned to eat the plants.

We animals have done this ever since. Those pirate specks, our ancestors, invented our particular way of meeting a need of food. They took it away from some one else. To this day all animals live by eating plants or by eating other animals who, in turn, have lived on plants. Plants alone know how to feed themselves. They know it so well that they are able also to feed the rest of the world.

At first the distinction between plants and animals was probably not a sharp one. Some of the specks were undecided for a while which path to take. They combined the characters of plants with those of animals. Indeed, there are still alive some tiny water creatures like this—creatures that are somewhat like animals, somewhat like plants. They are green and they can feed themselves, as plants do, but they can move about as animals do.

Scientists call these creatures flagellates because they possess one or more longish threadlike attachments called flagella, which is a Latin word that means whip lashes. The creatures wave these

(*Continued on page 120*)

CLARENCE A. O'BRIEN
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Man and His World

(*Continued from page 119*)

whip lashes about in the water and thus drag themselves along. Many bacteria that cause disease in our body also move by means of flagella, and scientists suspect them of being degenerate descendants of these primeval plant animals.

The surviving green flagellates give us, probably, some idea of what the primitive plant-animal cell was like, though we must not imagine that it was exactly like them. Every creature alive today has precisely as long an ancestry as we have. The flagellates have changed less than most others.

The real question is why we ourselves have changed so much. Why are not all of us still one-celled water creatures yanking ourselves along by waving threads?

The answer is that we have been *forced* to change. As the flagellates multiplied in the primeval sea, they began to compete with one another. There was not room for an unlimited number of them. So some of them began to live in colonies and became sponges. Others formed tubelike groups and became worms.

The Drama of the Living Past

Presently there were too many worms and some of them were forced to crawl up out of the sea into the rivers. These, as we shall see later, became fish. And after a while there were too many fish, so that some of them had to leave the water and live on shore. And out of these land dwellers there came, in the course of ages, man.

Thus runs the story of evolution, the great drama of the living past. The history of the rise of life; of lowly worms creeping about in the mud, of fish learning how to breathe air, of great reptiles dragging their 60 tons of flesh and bone along the shores of ancient swamps, of curious little catlike creatures peopling the forests of lands now buried under arctic ice, of how these creatures grew, at last, some of them to be monkeys, some apes, some men.

This is the story we shall tell in later chapters of this serial. But first we must tell how the story started.

Life began, we say, in the primeval sea, but what produced this sea? Was the earth always cool enough for life? Or, if it was once molten, what melted it? How did it grow and how was it born? What pulled it, in the beginning, out of the very body of the sun? And how did this sun of ours come into being among the great assembly of the other stars?

How did it happen, in short, that there came together here on this little dust mote of an earth, in the midst of the vast void of space, exactly that combination of heat and light and water and chemicals that made it possible for life to start?

This is one of the greatest mysteries still tempting the imagination of mankind. How modern science has begun to penetrate this mystery; how it has picked up the beginnings of the trail of life, the trail that leads down through unnumbered ages to end at last in man, will be the subject of our next chapter.

For Further Reading

The subject of this article is fascinatingly discussed in Dr. Henry Fairfield Osborn's "The Origin and Evolution of Life" (Charles Scribner's Sons, New York).

An excellent brief account of the evidence for the evolutionary idea is "Evolution and Animal Life," by Dr. David Starr Jordan and Dr. Vernon Kellogg (The Macmillan Co., New York).

On the scientific questions involved in the origin of life, a good short summary is "The Origin and Nature of Life," by Professor Benjamin Moore, published as Volume 63 of the low-priced Home University Library (Henry Holt & Co., New York).

THE HOME WORKSHOP

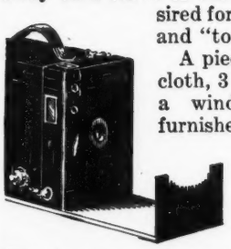
Making Money as an Amateur Portrait Photographer

LIKE millions of others, I owned a cheap camera and soon filled an album with interesting poses of every member of the family, but, as my wife often complained, the portraits were not "finished" like those taken "at the photographer's."

Critical comparison brought out the fact that the homemade portrait, if taken out of doors, usually showed "sun squints" and too much contrast between light and shadow, while those taken inside included sections of furniture or wall paper that could not qualify as good backgrounds. The professional photographer's portraits, on the other hand, usually started at the bottom with a solid, dark color that gradually "dissolved" into a soft, evenly lighted likeness of the sitter, against a background that was either a dark shade or a dark, hazy design.

A homemade portrait

To obtain a solid, dark colored foreground that would "dissolve" into a likeness of the subject proved a simple matter. I procured a piece of black cardboard as wide and twice as long as my camera, and to one end of it, at right angles, I fastened another piece of black cardboard by means of a paper "hinge." This piece was the same width and high enough to reach the center of the lens, as illustrated. The middle of the upper edge was then cut away on a curve of the size and shape desired for the finished print, and "toothed."



The vignette attachment

A piece of dull black oilcloth, 3 by 4 ft., tacked to a window shade roller, furnished a neutral dark background in conveniently portable form.

I placed my subject in a good diffused light, hung the oilcloth behind and set the camera on a table with the "saw teeth" directly in front of the camera at a distance of about 1 in. less than the length of the camera. Then I located the subject in the finder and made the exposure.

Because of their good quality and reasonable price, added to the fact that they can be conveniently made in the subject's own home, these amateur portraits, mounted in neat but inexpensive folders, enable me to offer my customers a service that fits in midway between the often unsatisfactory homemade "snapshot" and the higher priced work of the professional photographer.—GLEN WILLIAMS, Detroit, Mich.

INSTEAD of wiping off surplus paint from a brush on the edges of a paint can, drag the brush against a wire run across the center of the can at the top. The wire can be run through two holes punched in the tin with a nail.

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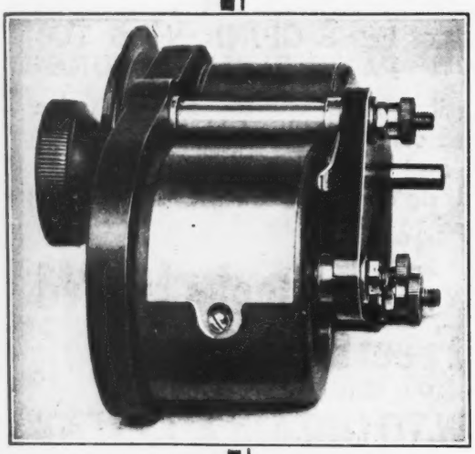

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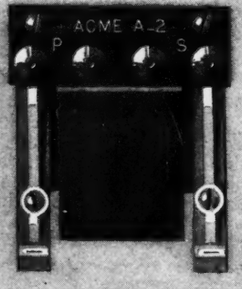

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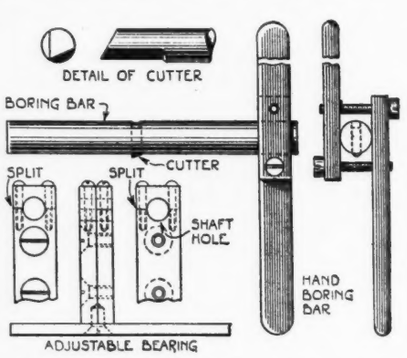
THE HOME WORKSHOP

How to Do Simple Lathe Work without a Lathe

By Howard Greene

MANY a time the amateur mechanic comes to a stopping place in his work for lack of a lathe. Yet in a large number of cases the obstacle can be surmounted satisfactorily.

A ½-in. hole in an iron casting, for instance, had to be enlarged, for a depth of an inch, to ⅝ in. This is how it was done: A piece of cold-rolled steel rod was found that was a snug fit in the hole. Through this a ⅛-in. hole was drilled. A cutting tool was made of a scrap of ⅛-in. round tool steel or drill rod, and this was driven into the hole, in which it fitted tightly. With the cutting end projecting about 1/64 in., the "boring bar" was inserted in the hole to be enlarged and the cutter was brought against the casting. The tool was turned by means of a handle clamped to the end. When the desired depth was reached, the cutter was driven out with a punch until it projected 1/64 in. more, and the process was repeated. Once the tool had been made, the actual



A simple hand boring bar and an ingenious homemade adjustable bearing

work required only half an hour. For bigger jobs of the same sort the tool could be turned with a brace; but for small work, turning by hand is much better, as very little "power" is required. It does not do to try to take too heavy a cut; quicker work can be done with a number of light cuts.

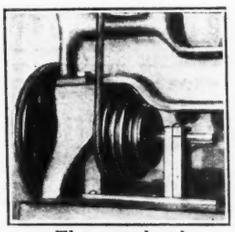
When disks of wood, fiber, and sheet metal are wanted, it is really easier to cut them with a common gasket cutter than to make them in a lathe. The important thing is to have the right kind of a cutting tool. No difficulty has been experienced in cutting fiber disks 6 in. in diameter up to ⅜ in. thick and brass disks 4 in. in diameter and ⅛ in. thick. It simply calls for a little elbow grease and a properly made cutter which has plenty of clearance, so that once the cutting edge has begun to work down, the tool will not rub and bind and make the edge of the disk ragged. A gasket cutter can be bought in any hardware store for less than a dollar, but the cutters will be found of little or no use except for very thin stuff. A new one will have to be made or, what is about as good, a new cutting edge can be ground on the butt end. Hardening and tempering will soften the original cutting end, but this will not matter much.

A grooved pulley to take a 3/16-in. round belt, which is the size of the ordinary sewing-machine belt, can be made from three disks of ⅛-in. fiber screwed together with machine screws, the fiber being

(*Continued on page 123*)

drilled and tapped as if it were metal. A rattail file ¼ in. in diameter at its thickest part will round out the groove. The center disk should be cut so that when the three are put together, there will be a groove ⅛ in. deep.

To fasten such a pulley permanently to the shaft, drill a small hole through the shaft to take a bit of steel wire—a wire nail is excellent—long enough to project about half the diameter of the shaft on each side. Cut a groove in the middle disk so that when the disk is slipped on the shaft, the wire pin will fit snugly in it. Then the outside disk is put on the shaft and the whole pulley screwed together, locking the pin and pulley solidly. This is a most satisfactory arrangement. Pulleys made in this way should be solidly screwed together, especially if they are more than, say, 3 in. in diameter. A 4-in. pulley should have about six equally spaced screws, all as close as possible to the edge. Glue may be used, but it is not reliable by itself, as it does not stick well to the belt fiber.



The completed countershaft

The writer has a small countershaft carrying a 4-in. pulley and a three-step cone, 1½, 2 and 2½ in., on a shaft of 5/16-in. steel drill rod. This is used to drive a small lathe and transmits the power of a 1/20-hp. induction motor, 3/16-in. round belting being used. The pulleys were made before the lathe was obtained and there is no lathe work on them, but they have been fully equal to the requirements, and the only result of six months' hard labor has been in smoothing them and making the belts grip better. Incidentally, the belts are laced with the gut of old violin E strings.

How Bearings Were Made

The bearings for this shaft were made in a rather unusual way and one that has worked out extremely well. Each bearing was made of two pieces of ordinary brass bar stock, ¼ by ¾ in. For each bearing, two pieces of the brass were cut long enough to give the bearing the proper height and they were joined with two ¼-in. machine screws, making one piece ½ by ¾ in.

The hole for the shaft was drilled through the ½-in. way. Then the two pieces were taken apart and split at the sides with a hacksaw and drilled and tapped for ⅛-in. machine screws for closing up the hole to take up wear. The peculiarity of the arrangement is in the fact that one of the halves of the bearing is split on the right and the other on the left. This makes possible a very fine adjustment.

As it is almost impossible to drill the bearing holes quite true with a hand drill, they were drilled 1/64 in. under size and reamed in position with a round file, finally being ground true with fine emery and a piece of the same drill rod used for the shaft. The "reaming" with a file is a mechanical crime, but it worked well.

The bearings are mounted in a 3/16-in. brass plate by means of two ¼-in. machine screws running up through the bottom of the plate and countersunk. After six months, there is so little shake that it is very difficult to detect it.

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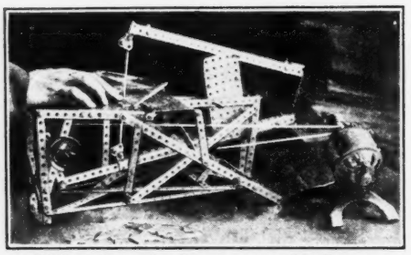
THE HOME WORKSHOP

Small Motor-Driven Fretsaw Is Simple in Form

By Ernest Bade

A SIMPLE fretsaw for light work such as toymaking and cutting out panels with pierced designs and puzzle pictures, can be constructed quickly and easily along the lines shown in the accompanying illustration. The framework of this saw is made from metal strips taken from a toy construction set, but other material will serve as well.

The first step is to make a table and its support. This must be as rigid as possible and so made that it can be securely fastened to the worktable or bench. The whole support can consist merely of a box placed upside down on the table, the far side being removed. The saw holder or



Although made of toy parts, this fretsaw serves well for light work

frame consists of two strips, a block and a spring. The long strips can be made of wood or simply be hollow tubes or fairly thick metal strips. A few inches from one end, one of the strips is fastened securely to the block; the other strip is pivoted to the block by means of a bolt, so that this arm is movable. The spring connects the shorter ends of the two arms.

This rocking beam is then loosely fastened with a bolt to two arms projecting from the back of the table. The whole beam should rock up and down freely.

A grooved wheel is fastened to the lower part of the table and connected with the front end of the lower rocking arm by means of a lever or connecting rod attached near the rim of the wheel. In this way the circular motion of the wheel is translated into an up-and-down movement. The saw blade is clamped to the upper and lower beams at the front. This is accomplished by cutting slots where the saw is to go and arranging bolts with wingnuts so that the sides of the slits can be pressed against the blade. A small electric motor belted to the grooved wheel provides the power.

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Cigarettes treated in this manner can literally be chewed without the smallest particle of tobacco reaching the mouth. The tip is practically tasteless and does not interfere with the full enjoyment of the smoke.—G. W. GREENE, Madison, Wis.

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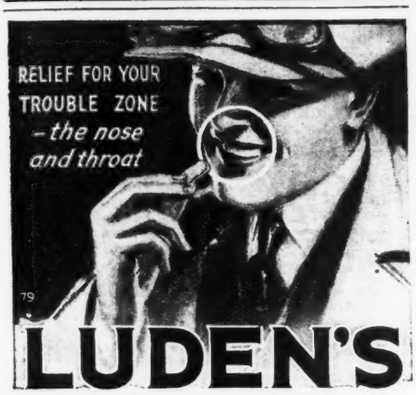

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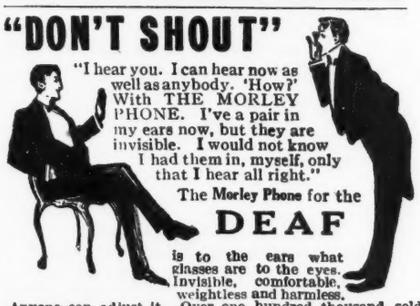

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THE HOME WORKSHOP

Folding Table Is Useful for Cards or Luncheon

By A. L. Morgan

MORE substantial than an ordinary folding card-table and practically as convenient to store away, the table illustrated will be found a useful article for many purposes. In winter it can be used as a card-table and in summer on the veranda or lawn for luncheon. The top can be taken off merely by giving the wooden clamp underneath about one eighth of a turn; the legs then fold together and the whole can be stored in a corner of a closet.

Figure 1 shows the complete table and Fig. 2 is a section through the top, which is made of ½ by 6 in. pieces of soft wood glued together and reinforced by two ½ by 3 in. cleats. The top is screwed to the ⅝ by 3 in. oak strips that form the skirt. The latter are neatly mitered together at the corners.

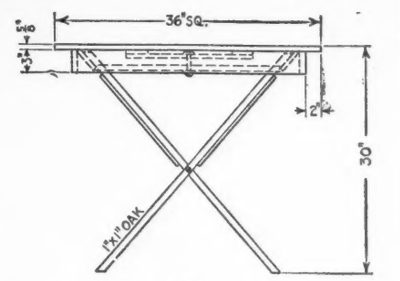

FIG. 1

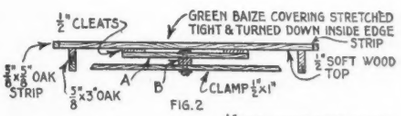

FIG. 2

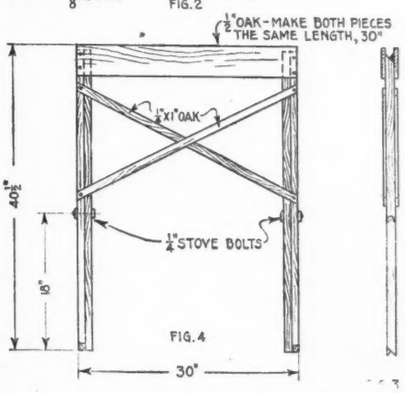

FIG. 4

The table open and closed, with the dimensions of the various parts

The clamp, Fig. 2, is of hard wood, beveled at the ends and long enough to engage the bottoms of the upper cross pieces of the legs. A ¼-in. stove bolt passes through its center, through a spacer *B*, and through a ½ by 3 in. piece, *A*, which is the last to be secured in place. The bolt should have a washer under its head and be riveted slightly at the threaded end after the nut is adjusted. To get the proper adjustment of the nut, turn the table upside down with the legs in place and lay the clamping unit in position. It will then be easy to get the proper thickness for the

(*Continued on page 126*)

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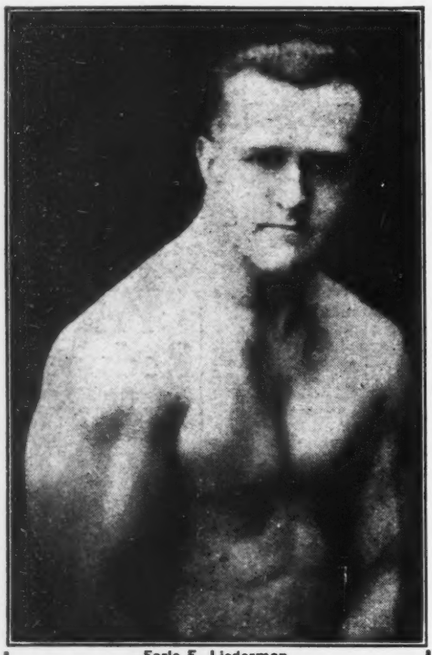

Earle E. Liederman
as he is to-day

If a Snake Had Brains—

He would still be a snake. With his present body he would be forced to continue crawling on his belly. So he would be no better off.

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A snake is the lowest and meanest of animal life, while mankind is the highest. Do you make use of your advantages? Your brain is used to direct your body. If you don't keep the body in fit condition to do its work, you are doomed for failure. How are you using this wonderful structure? Do you neglect it or improve it?

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A healthy body is a strong, robust one. Do you arise in the morning full of pep and ambition to get started on the day's work? Do you have the deep, full chest, the big, mighty arms and the broad back of a REAL HE MAN? Do you have the spring to your step and the bright flash to your eye that means you are bubbling over with vitality? If not you are slipping backward. You are not a real man and you cannot hope for the admiration or respect of others. *Awake!* Get hold of yourself and make yourself THE MAN YOU WERE MEANT TO BE.

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Substantial Folding Table

(*Continued from page 125*)

spacer to allow the clamp to move freely and yet have a slight spring when it grips the cross pieces on the legs.

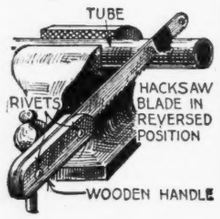
The top is covered with green baize, stretched tightly and tacked at the edge sufficiently to hold it until the oak finishing strips have been secured in place. These should be neatly mitered at the corners.

Figure 3 shows the end view of the legs when folded and Fig. 4 the front view. The diagonal braces are not mortised but simply sprung past each other and secured at each end with one screw. One pair of legs is made to fit between the other pair, and the pairs are held together by two bolts, which also should be riveted slightly to keep the nuts from loosening.

The woodwork can be finished with a varnish stain of any desired shade or shellacked.

Reversed Hacksaw Blade Cuts Thin Tubes Cleanly

FOR cutting insulating tubes of fiber or mica and thin brass or other light tubes, try using a reversed hacksaw blade. This can be used in the regular saw frame or provided with a handle shaped from a piece of hardwood and fastened to it with tape or rivets.

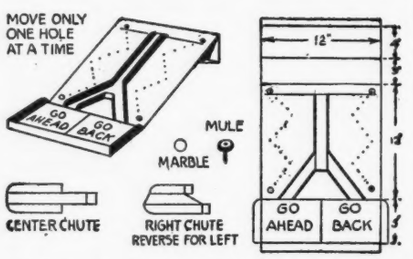


Light tubes are apt to be shattered when cut in the regular way, but using the reversed blade and a "pull" stroke lessens the danger. This method is also useful on heavier pipe when the blade tends to buckle and break.—M. F. A.

Mule Racing on Cardboard

THE drawings show how to make a new game in which the players each pretend to ride a mule. The rider who first crosses the line at the top of the hill is the winner.

Only two can play the game. Two push-pins represent the mules, or the heads of clothespins with 1-in. brads driven through their centers will serve. Place the mules on

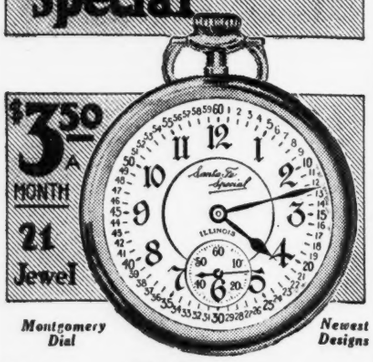


This simply made game gives the children endless amusement

the bottom holes. The first player then lets the marble roll down the chute and moves his mule according to the direction taken by the marble. The second player does likewise, and so on until the hilltop goal is reached.

Make the base of one piece of heavy cardboard 14 in. wide and 26 in. long. Cut out the three chutes from thinner cardboard and glue them in position.—D. W. CLARK.

Santa Fe Special



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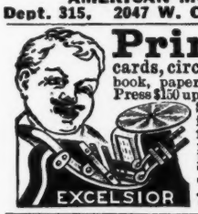

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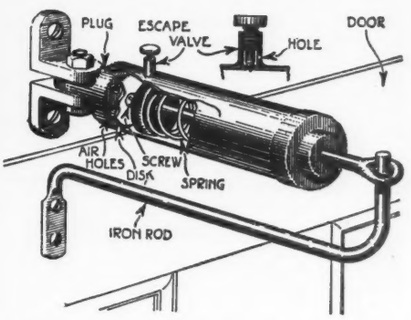
THE HOME WORKSHOP

Old Bicycle Pump Forms Pneumatic Door Closer

WHY pay a lot of money for a pneumatic door closer when you can make one yourself? The main part of this homemade door check is an old bicycle pump.

The cylinder is cut off at the lower end and plugged up with a round piece of brass, which has a projection through which a hole is drilled to take a bolt. This projection is held between two angles bent up from flat iron and screwed to the frame above the door about 1 ft. from the hinged side. A loosely wound spring is inserted around the plunger in the cylinder, and the cap is screwed on. The protruding rod is bent into a loop to accommodate a round piece of iron. This rod is bent in such a way as to engage the loop at one end and fasten to the door at the other end, which is flattened and drilled for screw holes.



The door closer in place, and detail of the adjustable escape valve

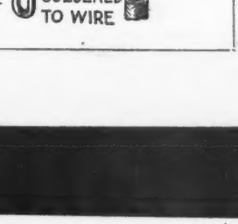
The piece of brass in the end of the cylinder has a series of holes drilled through it near the edge to admit air. Covering these holes on the inside is a steel disk fitted loosely on a machine screw. At the top of the cylinder is soldered a piece of tubing, threaded on the inside to hold a setscrew. The setscrew is ground as shown in the detail drawing. A small hole is drilled in the cylinder as a seat for the conical point, and another in the tubing near the lower end.

When the door is opened, the steel disk is pulled away from the inlet holes by the air that is sucked into the cylinder. As the plunger travels along the cylinder, it compresses the spring. When the door is left open, the spring pushes the plunger back and the air forces the steel disk against the inlets. The air then is expelled only through the escape valve. By adjusting this valve, the door can be made to close quickly or slowly, as may be desired.

If the plunger is well lubricated with heavy oil, the door closer will be found to give very satisfactory service.—EDWIN G. GETTINS, Los Angeles, Calif.

Links from Sash Chain Make Neat Terminal Connectors

NEAT terminal connectors can be made from an old sash chain. Cut off a link, open it, and flatten it out. Then cut one end of the link as shown and bend the other end around the bared terminal of the wire, soldering the connection thoroughly. — FRANK HARAZIM.



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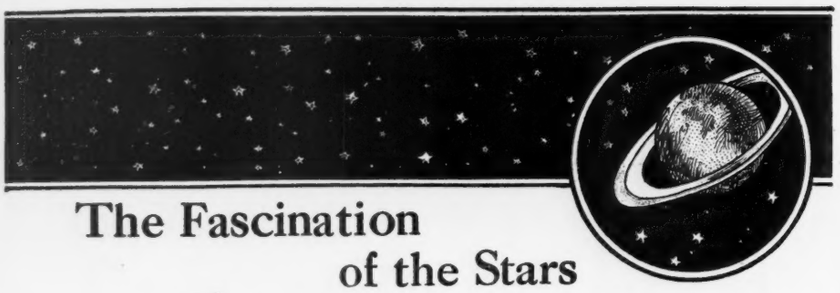

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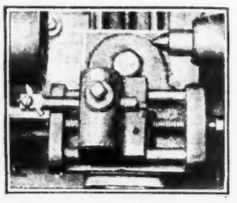
THE HOME WORKSHOP

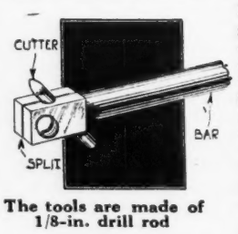
Miniature Tool Holder Increases Scope of Small Lathe

THE usefulness of a small lathe used by the writer for model work was limited by the fact that the tool holder of the slide rest provides for only two tool positions—one at right angles to the bed and the other parallel with it, and there was no provision for altering the height of the tool. Most of the inconvenience resulting from this arrangement was overcome by making a small tool holder, as illustrated.



The tool holder in use on bench lathe

A piece of ⅜-in. square cold rolled steel was put in the lathe and 2 in. of its length turned down to ¼ in., this being the size of the regular tools. Half an inch from the shoulder the bar was cut off, leaving a piece 2½ in. long, with ½ in. square and the rest round. Through the square part a ⅛-in. hole was drilled at an angle for the cutters, and a hacksaw cut was run from the end of the square part to meet the hole. Lastly, a hole for a pinching screw was drilled beyond the tool hole, enlarged to clear the screw above the split and tapped below the cut.



The tools are made of 1/8-in. drill rod

Tools were made of ⅛-in. drill rod, filed to shape, hardened and tempered to a light straw color and finished on an oilstone. In spite of their smallness, the cutters have stood up well and given no trouble whatever. This little device has very greatly increased the usefulness of the lathe and has proved excellent for inside work, such as boring.—H. G.

Flame Removes Broken Handle from Eye of Ax

WHEN the handle of an ax, hatchet or hammer breaks short, so that a tightly wedged piece of wood is left within the tool, the eye can be cleared by using an alcohol lamp or bunsen burner as shown.

A gentle but continuous blast is blown through a blowpipe so that the intense heat

Blast from blowpipe burns hole through tightly wedged wood

concentrated at a point will soon burn a hole through the wedged fragment of the handle. With this hole as a starting point, it is the work of but a few minutes to remove the charred pieces remaining in the eye. The most stubborn and firmly fixed handle can be taken out in this way.—E. B.

THE HOME WORKSHOP

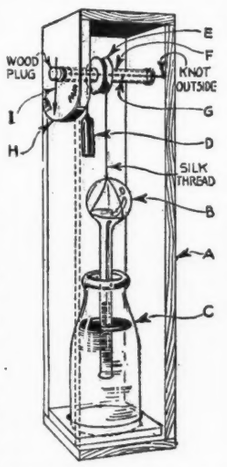
Simply Made Weather Telltale Gives Warning of Storms

By E. A. McCann

ALTHOUGH this apparatus must not be considered as a really scientific instrument, it is easily made and as a rule will give warning of fine or wet weather, storm or calm.

First, get a glass jar, *C* (a milk bottle will do), and a flask, *B*, from the drugstore; then, to fit them, build a framework, *A*, which is just an incomplete box, with back, top, bottom, sides, and a partial front. The instrument may be entirely inclosed if sufficient openings are left for the air to get in and out freely.

A piece of brass tubing, *F*, about 3½ in. long, fits a socket in the back and goes through the front. Plug the front end with a piece of wood and into the plug screw a light pointer, *I*. To the back of the plug fasten a piece of catgut, which runs right through the tube and out at the back, as at *G*. Thread the tube through the front and fasten the pulley, *E*, tightly to the tube so that it is over the center of the jar. Leave the gut hanging loose for the present.



The telltale with one side removed to show construction

Now, hang the flask *B* in a wire sling and fasten a silk thread to the wire. Run the thread over the pulley, hanging a weight, *D*, on the other end, a little less than heavy enough to balance the flask when partly full of water. You can adjust this later on when the flask is inverted. Make a dial with "Fair" on one side and "Wet" on the other, and fasten it to the front of the box.

Fill the jar or bottle about a third full of water and fill the flask and turn it over in the jar. Most of the water will run into the jar. Until you have a balance, twist the catgut toward the side on which the weight hangs, and fasten it off behind. Pour a little oil on the surface of the water to prevent its evaporating. You can color the water if you like. Do not put the instrument in the sun.

When the weather gets warm, the air in the flask expands and forces some water out, so that it becomes lighter and rises. Warm air is lighter than cold air—which is the secret of most of the changes in the weather—so the weight being less on the surface of the water in the jar, again the water in the flask falls and it rises and in rising, turns the pointer. Also warm air holds more moisture; this acts on the catgut, twisting it, and helps to turn the pointer. You can dispense with the catgut, but it is a help. When the air gets colder, the reverse of all this happens, and the pointer goes the other way. So you have a barometer—on the surface of the water; a thermometer—in the top of the flask; and a hygrometer—in the catgut.

When the telltale falls, you may expect

(*Continued on page 130*)

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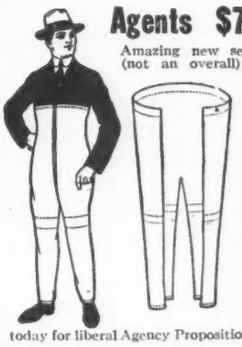

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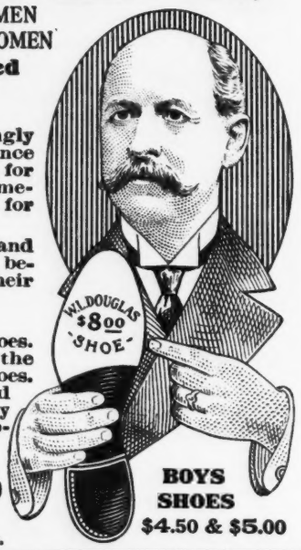

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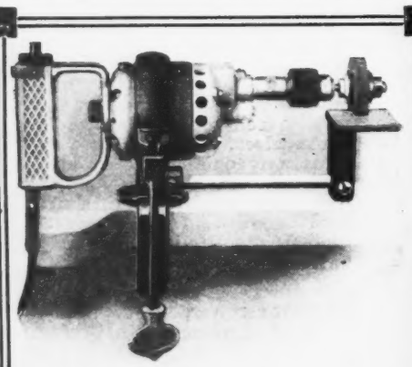

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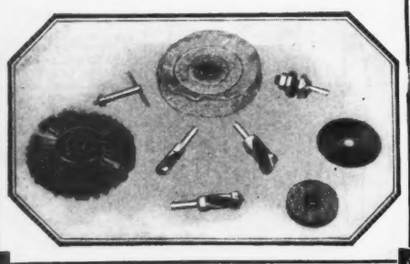

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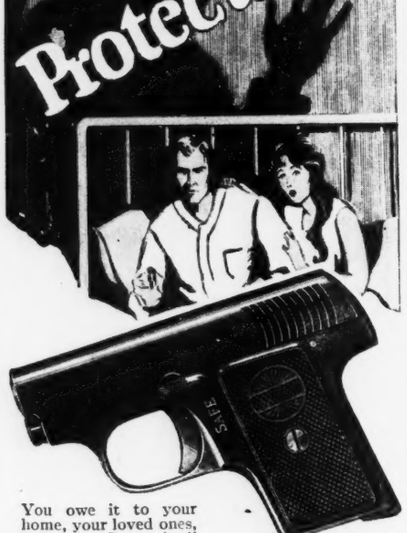

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Both models are exceptionally fine guns that usually retail from $15 and $25 up. The very finest quality forged steel and expert workmanship throughout. ABSOLUTELY GUARANTEED against defective workmanship and materials! If you are not entirely satisfied, return within ten days and we will return your money at once.

SEND NO MONEY

unless you wish. Write clearly your name, address and model you wish and we will ship by return mail. You pay the postman upon arrival. Write for our new firearms catalog.

California Trading Company
Dept. 133 Terminal Bldg., Los Angeles

THE HOME WORKSHOP

Simply Made Weather Telltale

(*Continued from page 129*)

southerly winds, with rain, especially if the clouds are from the same direction. You will get longer notice of a southerly than of a northerly wind. If the air is dry, but still it falls, expect snow in winter. If it rises, expect northerly winds and finer weather. The quicker it rises, the more wind you may expect. If the wind is in the south and it rises, expect fine weather. The slower it rises or falls, the longer will the coming weather last, and vice versa.

If it stops high and steady, expect dry, fine weather; the more it jumps about, the more unsettled the weather will be. A sudden rise is as likely to bring a storm as a sudden fall. But you will learn most by watching it and the clouds, which are great weather prophets to one who knows how to read them.

A Window Flower Garden

A CONVENIENT and decorative window garden may be made by attaching a ledge or board to the lower sash. The board must be as long as the glass is wide, and about 4 or 5 in. wide. A tiny railing on three sides is made from strips of wood about ⅜ by ⅝ in. and heavy wire.

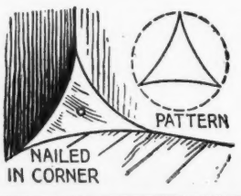
Two other wires about 10 in. long are attached to the board at the ends and to

This neat flower pot holder is attached directly to the lower sash

the sash to serve as braces and hold the stand in a horizontal position. A screw through the shelf down into the lower sash rail will hold the stand in position and prevent it from being accidentally dislodged. When the lower sash is opened, the plants rise with it, thus allowing the unobstructed circulation of air.—B. E.

One Nail Holds Corner Piece

BY CUTTING out "dustless" corner pieces as shown, they can be fastened in place in stair corners and in the corners of rooms where they are needed with one nail apiece. Driving the nail slantwise into the corner draws in the center of the triangular piece firmly and makes a neat, quick method of fastening as shown here.



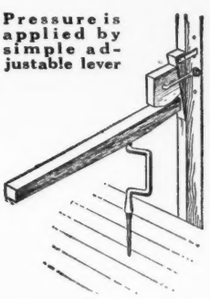
When I require a supply of these corner pieces, I simply cut them from scrap tin and paint them.—JOHN R. DODGE, Normal, Ill.

THE HOME WORKSHOP

Rig Makes Light Work of Drilling and Boring by Hand

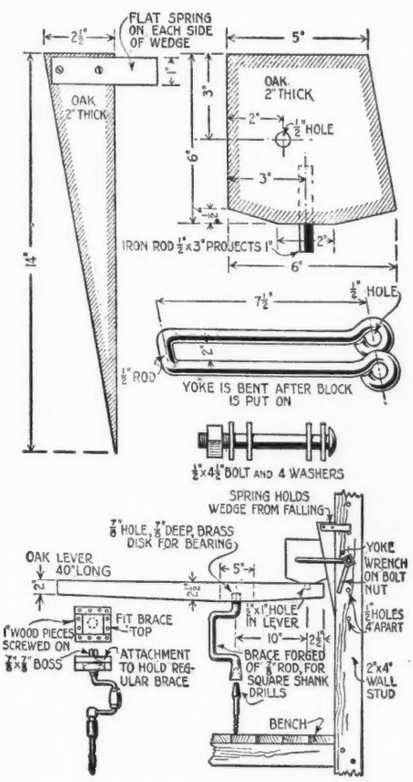
By Henry S. Laraby

WHENEVER heavy drilling or boring is to be done in the home workshop and no machine is available, much labor may be saved by constructing a drill rig like the one illustrated. It is easily adjusted, has few parts, is very strong, and takes up no room when not in use. Either a regular hand brace can be used in connection with it, or a brace may be forged from a ⅛-in. rod.



Pressure is obtained by means of a lever of oak or other hard wood, 40 in. long. The fixed end is fastened to a wall stud or a "two by four" at the back of the bench by means of a block, yoke, and wedge, which are adjustable as to height. The block has a lug, which engages a hole in the end of the lever and in the under side of the lever is a bearing for the brace.

Ample adjustment is provided for boring work of various sizes because the holes for the yoke are 4 in. apart and the wedge permits any adjustment within 4 in. A saw-horse can be used in place of the bench. In fact, if the ½-in. holes in the stud are run from the floor up at 4-in. intervals, any working height may be obtained. In operation, the lever is pressed down under the left arm and the right arm is used to turn the brace.


FLAT SPRING ON EACH SIDE OF WEDGE
OAK 2" THICK
OAK 2" THICK
1" HOLE
IRON ROD ½"x3" PROJECTS 1"
YOKE IS BENT AFTER BLOCK IS PUT ON
½"x4½" BOLT AND 4 WASHERS
SPRING HOLDS WEDGE FROM FALLING
⅞" HOLE, ⅞" DEEP, BRASS DISK FOR BEARING
OAK LEVER 40" LONG
YOKE
WRENCH ON BOLT NUT
½" HOLES 4" APART
FIT BRACE TOP
WOOD PIECES SCREWED ON
⅞"x⅞" BOSS
ATTACHMENT TO HOLD REGULAR BRACE
1"x1" HOLE IN LEVER
BRACE FORGED OF ⅞" ROD, FOR ½" SQUARE SHANK DRILLS
2"x4" WALL STUD
BENCH

How the parts of the heavy boring rig are made and assembled

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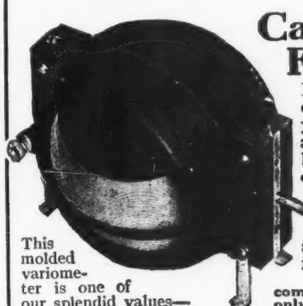

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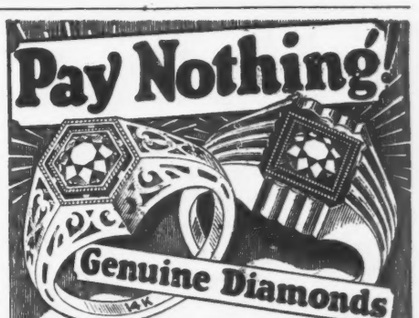
Make money by selling your friends and neighbors this radio equipment at prices that will save them money.

complete only..... $5.50

Columbia Radio Corporation
2757 Diversey Avenue, Chicago

Pay Nothing!



Save 25% on this **solid gold, genuine diamond** ring. Read this—the most amazing **free trial offer** ever made.

No Money Down—No C. O. D.

Mail the coupon below—**don't enclose a penny**—and we'll send you either the man's or lady's ring shown above on trial, all charges prepaid. Pay nothing when the ring arrives—**no C. O. D.** wear it a week—then decide. If you can duplicate this ring for $50.00 anywhere, send it back at our expense and that ends the matter. If you decide to buy, send $3.75 after trial, and pay $3.75 a month until our **special cut price of $38.75** is paid. (Over 10 months to pay—no interest).

Each ring is **14K solid gold**, exquisitely hand made, engraved and beaded. The **18K white gold** top is set with an extra brilliant, blue white, perfectly cut, top quality **genuine diamond. (Regular $50.00 value—now only $38.75).** You risk nothing on this wonderful offer! Mail coupon today! Be sure to state finger size.

Mail This Coupon

Harold Lachman Co., 204 So. Peoria Street Dept. 1783 Chicago, Ill.

Send me free of all charges the **solid gold, genuine diamond** ring checked below, for a week's free trial. I enclose no money—I will pay nothing on arrival. At the end of one week I shall either return the ring to you by registered mail, or send you first payment of $3.75, and then $3.75 on the first of each month until your cut price of $38.75 has been paid. Title remains with you until fully paid. **I enclose my finger size.**

☐ Lady's Ring A4350. ☐ Man's Ring A4450.

Name .....

Home Address .....

City ..... *State* .....

Age ..... *Occupation* .....

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You can earn $15 to $50 a week writing show cards in your own home.—No canvassing.—A pleasant profitable profession easily and quickly learnt by our new simple graphic block system. Artistic ability not necessary.—We teach you how, and supply you with work—Distance no object. Full particulars and booklet free.

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"We pay him $100 a week"

"AND he's worth every cent of it. Came here several years ago asking for a job. He got just that—a small job at a small salary.

"Then I forgot about him—hardly knew he was on the payroll until one day I got a letter from the International Correspondence Schools telling me that he had enrolled for a course of home study. It was remarkable the way he went ahead.

"We pay him $100 a week now and he's going to be earning even a larger salary some day. I wish we had more men like him."

HOW do you stand when your employer checks up his men for promotion? Does he think of you? Is there any reason why you should be selected? Ask yourself these questions fairly. You must face them if you expect advancement and more money.

One hour after supper each night spent with the I. C. S. in your own home will prepare you for the position you want in the work you like best.

Yes, it will! Put it up to us to prove it. Without cost or obligation, just mark and mail this coupon.

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Without cost or obligation on my part, please tell me how I can qualify for the position or in the subject *before* which I have marked an X:

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☐ Nicholson Cost Accounting	☐ Railway Mail Clerk
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☐ Mechanical Draftsman	☐ Architectural Draftsman
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Our big stock of standard makes of radio sets, parts and supplies, fully illustrated, Play safe — buy standard equipment from a reliable house. We ship from stock.

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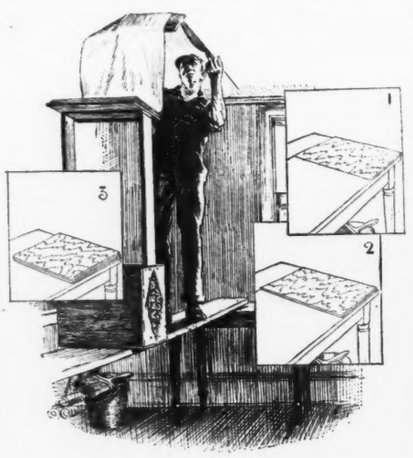
The Shipshape Home
How to Do the Odd Jobs

Papering Ceilings

ALTHOUGH the difficulty of papering ceilings is what deters many home workers from doing their own paperhanging, it is not really hard to do, and if the proper system is followed, an amateur can quickly learn to paper ceilings as deftly as a professional.

A plank, or two planks, long enough to reach from one wall to the wall opposite must be provided. It should be raised on tables or other supports so that the ceiling can be reached comfortably with the palms of your hands. A paperhanger's smoothing brush, or a clean whiskbroom, and a photographic roller are necessary, although a caster will take the place of the latter for rolling seams.

You will also need what I call a "little helper." This is made by nailing two wooden strips about 4 ft. long inside the



ends of a soapbox, as shown. A piece of lath is nailed across the top and on this is fastened a heavy sheet of pasteboard about 1 by 2 ft. This makes a light but firm stand.

After removing both selvage edges, cut the paper about 6 in. longer than the room is wide or long, depending upon which way the paper is to run. It is best always to have the seams run toward the light. Cut 5 or 6 lengths at a time and spread them, printed side down, one over the other on the kitchen table or whatever is to be used as a pasting table. Place the paper about 2 in. from the edge of the table, loosen the top strip, draw it toward you until the nearest edge is even with the edge of the pasting table, and apply paste for about 3 ft. from one end, brushing the edges outwardly. Double the paper about 1½ ft. from the end and fold the pasted surfaces together, taking care that the edges match on both sides, as shown at 1. Pull the strip along until you have an unpasted length on the pasting table and apply paste to another 3-ft. length. Lift the paper at the place where the end has been folded over the pasted surface and fold over the newly pasted section, as shown at 2. Repeat this process until the entire strip is pasted and folded as at 3.

Place the pile of paper on the little helper in such a position that when you take up the beginning of the strip the pasted side

(*Continued on page 133*)

DID you know that you can get Regenerative sets at reasonable price in RadioCraft's D-4, with the D-5 2-Step Amplifier? These fine sets are made of De Forest parts—and carried by De Forest dealers. See them!

THE RADIOCRAFT CO., INC.
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STUART'S PLAPAO-PADS are different from the truss, being mechanico-chemico applicators made **self-adhesive** purposely to hold the distended **muscles** securely in place. **No straps, buckles or spring attached**—cannot slip, so cannot chafe or press against the pubic bone. Thousands have successfully treated themselves at home without hindrance from work—most obstinate cases conquered.

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Everywhere in California auto men are wanted. Good jobs at big pay open NOW. Men can't be trained fast enough to supply demand. California is crowded with autos. Has more autos to population than any other state in Union. Greatest shortage ever known of garages and skilled auto mechanics.

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Now's YOUR opportunity to step into this big money-making business. YOU can become an electrician, mechanic, ignition expert, garage foreman or used-car appraiser after a few short weeks training. We'd like to tell you here how thousands of men have gained big-pay auto jobs through NATIONAL training. But it's a long story, and we've put it all in a handsome illustrated book which also tells everything about NATIONAL AUTOMOTIVE. Wonderful big training shops right next door to 130-acre city park. Ball parks, swimming pool, world's largest stadium—all free to you. Send for this book now.

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Hundreds of men write: "I have increased my earnings 100%." "I have built a wonderful garage business, and owe it all to National." "I am well satisfied with National training; am sending my brother to take the course."

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Send for Big Free Auto Book
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An "Old Town Canoe" means happiness for you and the only girl. Means afternoons together, drifting down winding streams—lazy-paddling on quiet waters.

Canoeing is one of the greatest of summer pleasures—and the cheapest. For an "Old Town Canoe" will last you for years. And it is the lowest-priced canoe made. $54 up from dealer or factory. It is the lightest and steadiest of canoes, too!

The new 1923 catalog shows all models in full colors. Write for one today. It is free.

OLD TOWN CANOE CO.
1393 Main Street, Old Town, Maine, U.S.A.

THE HOME WORKSHOP

The Shipshape Home

(*Continued from page 132*)

will be toward the ceiling. Lift the stand on the scaffold and place it about 4 ft. from the end where you intend to begin papering.

Take the end of the paper in both hands and attach about 1 ft. of it to the ceiling by pressing it with both hands and smoothing it with the brush or whisk. Take every care to start with the long edge of the paper exactly even with the edge of the ceiling and wall. If you do not start right, you will have to take the paper off and begin over again, but that is not difficult to do if you have not taken more paper off the little helper than you can handle.

If there are any wrinkles that cannot be brushed out, loosen the paper back to the wrinkles and brush it on again. Work quickly but do not hurry too much, as the paste will remain damp for some time. Hold the paper against the ceiling with one hand and move the helper about 2 ft. with the other, letting the paper slip off the pile. Brush the center of the paper until the slack is taken up and then brush outwardly toward each edge. Repeat this process until you are about 4 ft. from the wall.

Then, using a roll made of odds and ends of cut pieces, take the remaining paper from the helper and support it with the roll. You can then brush down the center clean to one end, and return and brush out each edge. Look back to see if there are any wrinkles or bubbles. If so, smooth them with the roller.

Paste another length and repeat the procedure. See that the edges overlap so that one edge just covers the other. The tendency is to have too large an overlap. When the second sheet has been applied, roll the seam.—A. M. SMYTH, Germantown, Pa.

Painting Hints

FOR work that is smooth and in good condition, 1 gal. of paint of standard quality will cover from 600 to 800 sq. ft. with one coat or half that with two coats.

Fill all nail holes, cracks, and crevices with pure linseed oil putty, after the first priming coat is dry.

For house painting, use a long flat or oval bristle wall brush, and see that the paint is well worked into the wood. In applying the priming coat, do not try to cover the grain of the wood simply by piling on the paint thickly. Several thin coats are better than one heavy one.

For three-coat work, the second coat should have sufficient turpentine added to reduce the surface gloss. The third coat will then stick better than it would to a glossy second coat. If the paint for the finishing coat seems somewhat heavy, add a little raw linseed oil. Always allow at least 48 hours between coats.

Choosing Colors

IN SELECTING tints for house painting, it is best not to duplicate the colors of neighboring houses, but to choose colors that will harmonize. If you wish your house to stand out, use the lighter tints. Brilliant colors are best for small houses.

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You can qualify for a good-paying position by devoting spare time at home to a series of easily understood, inexpensive lessons, known as the Hotel Operation and Management Course covering every phase of the hotel business. Compiled by nationally known hotel experts; our method of training endorsed by leading hotel executives such as Roy Carruthers, Managing Director, The Waldorf-Astoria, New York; Senator Van Orman of the Van Orman hotels in the Middle West, and others.

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Send me free booklet No. 1188 giving full information about Hotel Operation and Management Course; also Employment Bulletin.

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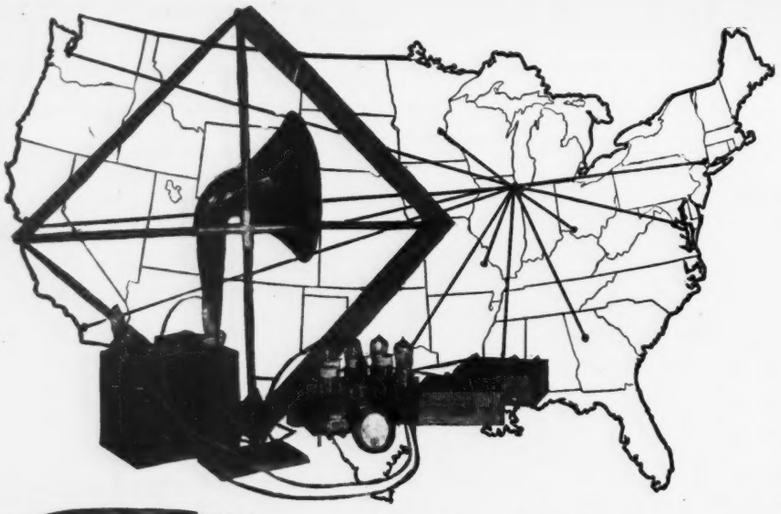

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Four Tubes Now Do the Work of Seven

Again Erla offers invaluable contribution to radio science. The Quad-Six Super-Radio-Frequency Circuit—an Erla achievement—takes first place among the notable discoveries of the year.

Six stages of amplification—four radio and two audio—are secured with the use of but three amplifying tubes, and a detector, giving the efficiency of the best seven-stage circuits of conventional design.

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That's what R. Berger makes by just showing housewives the amazing New Kind of Heat that does away with dirty coal and wood, eliminates worry about coal shortage and high prices. Hundreds making fortunes, too, with Oliver Oil-Gas Burner. 3 times the heat of coal—at turn of valve. Burns 95% air, 5% oil. 100,000 sold. Sells itself. Agents clean up. Write for exclusive territory and special offer at once. **Oliver Oil-Gas Burner & Machine Co., 2007-O Oliver Bldg., St. Louis, Mo.**

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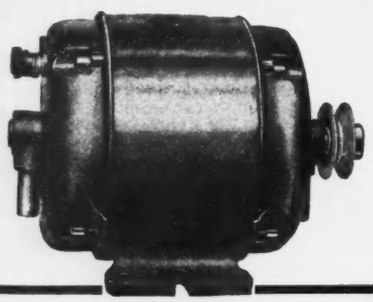

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—6 and 7 inch wheels, same motor fan-cooled and dust proof.

Send cash with order. Our money-back guarantee protects you. Write for Bulletins describing these and other sizes.

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Italian Period Buffet

Yours for 20c a Day

A complete Dining Suite if you wish or single pieces in this same design, the imposing Italian Renaissance. This Buffet, China Cabinet, Chairs, Table, all in genuine American Walnut, the popular two-tone finish. Description, low prices, easy terms, in our big Larkin Book of Better Homes, showing over 1000 attractive offers of Furnishings for the home. Check below for offer interested in.

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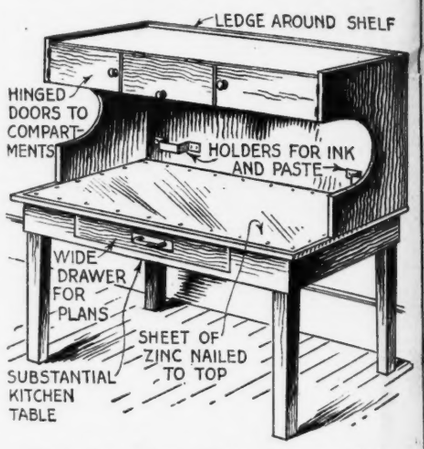
Larkin Co Inc.
Desk FPSM-323 BUFFALO, N. Y.

THE HOME WORKSHOP

Table Makes Inexpensive Desk for Small Shop

AN OAK rolltop desk would be out of place in the small workshop and would soon get scratched and scarred, but a desk almost as serviceable for keeping correspondence, reference books, plans, and miscellaneous data, can readily be made from a kitchen table. Such a table in unpainted pine or oak can be obtained for a few dollars.

Fix a sheet of zinc to the top of the table, fasten two uprights at the ends, as shown,


LEDGE AROUND SHELF
HINGED DOORS TO COMPARTMENTS
HOLDERS FOR INK AND PASTE
WIDE DRAWER FOR PLANS
SHEET OF ZINC NAILED TO TOP
SUBSTANTIAL KITCHEN TABLE

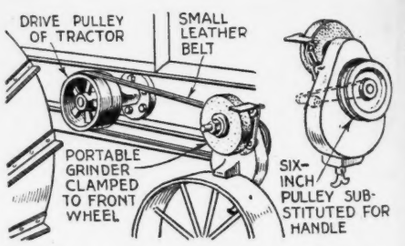
Made for a few dollars, this modified table serves every need of a desk in the home workshop

and make a boxlike shelf arrangement with hinged doors. The zinc will stand unlimited abuse and can easily be kept clean by rubbing it with a piece of waste. The long drawer under the table top holds rolled prints, while the smaller compartments above provide a place for drawing instruments, books, papers, miscellaneous data and other items that cannot safely be placed in a bench drawer.—H. L. F.

Tractor Pulley Drives Tool Grinder Clamped to Wheel

IN SHARPENING those farm tools that ordinarily are sharpened on an emery or carborundum hand power grinder, much time can often be saved by driving the grinder from the tractor pulley, as illustrated.

The handle of the grinder is removed and a 5- or 6-in. pulley substituted. The


DRIVE PULLEY OF TRACTOR
SMALL LEATHER BELT
PORTABLE GRINDER CLAMPED TO FRONT WHEEL
SIX-INCH PULLEY SUBSTITUTED FOR HANDLE

A labor saving arrangement for the farmer in sharpening tools and blades preparatory to spring work

grinder is then clamped to the rim of the tractor wheel or to any support that will bring its pulley in line with the broad face of the tractor drive pulley, and a short length of belting is used to connect the two.

If several cutting wheels are provided for the grinder, practically every form of knife tool, from a mower blade to a circular saw, can be sharpened in this way.—G. A.